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73 MAGAZINE

September 1968
Vol. XLVII No. 9

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Tech. Editor

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Stop reading this fine print. Look at page 92 and go out and sell subscriptions.

Editorial Liberties

I would like to take this opportunity to introduce 73's new Technical Editor, Jim Ashe W2DXH. Those of you who are among 73's Fandom will recognize Jim from his many fine articles in the past few years. I consider myself fortunate that Jim agreed to come to work for us, where he will be underpaid, overworked, and rewarded mainly by knowing that he is helping to maintain (would you believe improve?) 73's standards for technical articles. He's only been here two days as of this writing, and he has pitched in like a trooper and is taking much of the load off my shoulders and mind. It's nice to have a man around the shop! Look for great things!

Hardly a day goes by when I don't receive at least one letter from an amateur saying that he has given up CQ and QST and only subscribes to 73. This is flattering, but . . . ! I'm not opposed to your dropping your subscription to CQ, but when you drop your subscription to QST it means you are no longer a member of the *only* organized body devoted to amateur radio and it's purposes.

ARRL may not be the best, but, let's face it, ARRL is all we have. If you are unhappy with what the League is doing (or not doing) you won't accomplish anything by resigning any more than you will change the Government by refusing to vote. If you don't like what the League is doing, this is the time to speak. Elections for Division Directors and Vice Directors are taking place in the following Divisions: Central, Hudson, New England, Northwestern, Roanoke, Rocky Mountain, Southwestern and West Gulf. If your director has not done what you feel is to the betterment of ham radio, get out and do something to change it rather than resign.

The rules of the game are roughly as follows. To be a Director or Vice Director you must have been a member of ARRL for five consecutive years without a lapse. You must have a nominating petition signed by 10 League members to HQ by noon on September 20, 1968. You must hold a General Class (or higher) License. And, you should be prepared to work hard to improve the deplorable conditions which now prevail.

If your are not in a position to run for the office, you might take a close look at the man who is opposing the incumbent in your Division. You might just find that you have a pretty good guy who is willing to work hard to give ham radio the necessary boost.

I certainly don't want to stir up the late AM-SSB quarrel again. I work SSB/CW/AM in that order of preference (when I have time to be on the air at all) and feel each has it's place in our hobby. However, there is AM and there is AM with so-called "Super Modulation." The lead article in July CQ on "Modulation Unlimited" seems to me to be a matter of irresponsible editing. That article was in the files at 73 when I came to work here last year. We had paid for it, but the check had never been cashed. I read it and thought what a wonderful article it was for about 15 years ago. It contained nothing new. 73 had already printed a similar article in Feb., 1963. The drafting had been done, the article was already in type and ready for print, but after a close scrutiny of the signal in question on the air, I was convinced that this was definitely not "state of the art" and left it in the file. On the request of W3PHL's attorney, the article was returned to him a couple of months ago. CQ then printed it in their July issue. I'm glad the egg is on Dick Ross' face, not mine. From the information I have been able to gather, the author has had his license suspended for, among other things, excessive broadness of signal. When a signal takes out over 15 kHz on a fairly sharp receiver, it has no justification in my book. Work whatever mode pleases you, but keep it clean and sharp.

A note to prospective authors. We are still eager to read your manuscripts and hope you will write about what you are doing. The August issue contained an article by Ken Sessions K6MVH entitled "Hamwriting" which should act as a guide to good writing. To assist further, pages 94-95 in this issue contain two charts giving all the electronic symbols used on schematics and the abbreviations used both on schematics and in the text. I would like to suggest that you keep these charts handy for reference when writing. You see, I am basically lazy and the fewer corrections I have to make to your manuscript, the better I like it.

. . . Kayla W1EMV

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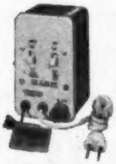

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de W2NSD/1

Miller Confesses!

When word came that Miller had admitted the St. Peter and Paul Rocks hoax expedition I was relieved, but not really surprised. I was aware of a good deal of the evidence that the League had gathered against him in this and about twenty other of his operations. The PY0XA trip was of critical importance though since it was the *only* one where he had a surviving accomplice. I suspect that when Miller found that his accomplice was not about to chance imprisonment by lying under oath that he was trapped into confessing.

Where was he at the time he was claiming to be operating from the Rocks? Well, his license was running out and he didn't have time to get all the way down there to the middle of the Atlantic Ocean off Brazil, so he operated just off the coast of Venezuela, probably near Trinidad on board a ship and a good 1800 miles from St. Peter and Paul.

Miller has withdrawn his suit against the League and Huntoon and I expect that the suit against 73 and myself will be withdrawn shortly. Don't feel too badly if you were taken in by Miller and his stories. He is most convincing and audacious. If there is any rational reason for his doing the things he has done and acting the way he has acted, none of us intimately involved have been able to figure it out.

I understand that Miller's explanations for the other questioned expeditions were vague, contradictory and evasive. Proof of anything? Sorry, but most of the records have been lost or stolen. Passport? Lost that too, just recently.

The League would certainly seem, on the strength of the testimony given, to have adequate grounds for deleting credit for about twenty of Miller's operations. Pressure from DXCC members will probably force them to accept all but the most outrageous.

Where does this hoax confession leave CQ and their seemingly fictional series by Miller. How about the Miller DX book, promised about a year ago? Will CQ bring this out in the face of his disgrace? CQ has backed Miller to the hilt with their reputation . . . where does his confession leave them? Will they give us a public apology for the libelous attack on me they published for Miller?

If you have any friends who stopped reading 73 because I was writing bad things about their hero, you might pass along the word.

UFO NET SCHEDULE

Wednesdays 0200 GMT 14,300
Thursdays 0200 GMT 3950

Net Controls Needed

The UFO Reporting Net has been growing larger every week and now is much too large to permit all of the interested stations to check in. The net has been meeting on 14.3 MHz every Wednesday night at 0200 GMT.

Jim Sipprell K2HYQ has kindly consented to take on the organization of net controls for nightly operation of the net. The frequency will continue at 14.300 MHz and the time at 0200 GMT. If you are interested in acting as a net control one or two nights a week please drop a note to Jim. You should have a good signal and be dependable. Jim will pick out two for each night that are widely enough separated so they should be able to hear all checkins. We've found that we can get just about everyone with one control up east and one in the south . . . or one in the west and one in the south, etc.

If you can't be sure of being available on any particular night you should call into the net whenever you can make it. The net control stations will keep you informed on how things are going and will be interested in any reports you have to pass along.

To participate in the UFO Reporting Net you should set up communications with your local agencies that might get reports of sightings or would be interested in knowing of nearby sightings. You should talk with your

Turn to page 114

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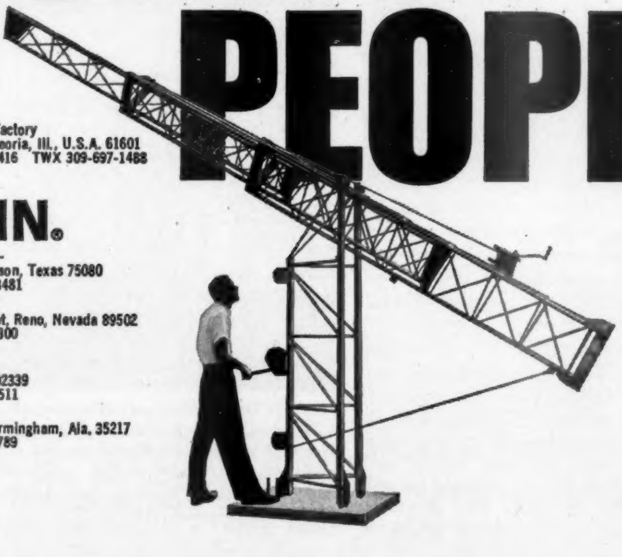


Going VHF - In The Mobile

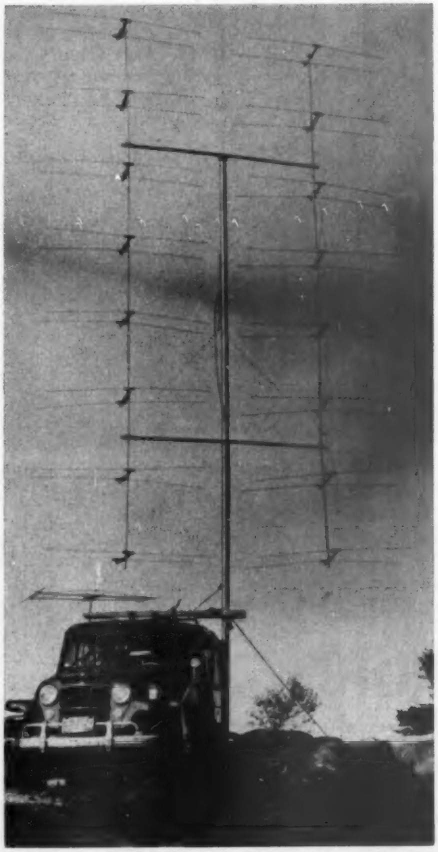
Robert M. Brown W9HBF
5611 Middaugh Ave.
Downers Grove, Ill. 60515

VHF mobileers claim it's the greatest — if you know what you're doing. This article outlines mobiling's role on the bands above 50 MHz, what you can expect, and some useful tips from the experts.

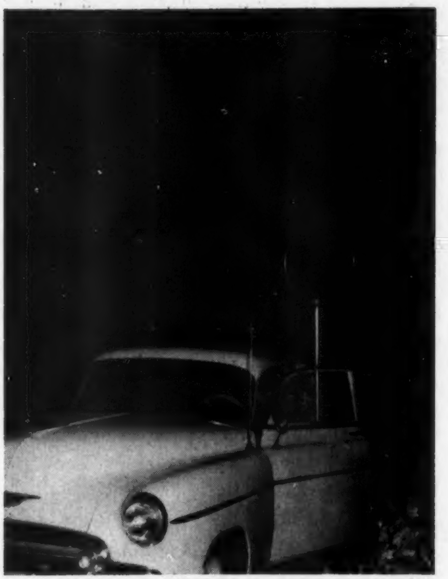
To the reader uninitiated in the fine art of exploring VHF from the auto, above 50 MHz mobiling may sound like a total waste of time. Indeed, there are thousands of low-frequency hecklers who'll tell you that (1) ignition noise is too severe, or (2) that there is never anyone on in your area, or (3) you'll be lucky if you can work out of town. The more experienced reader may claim just the opposite, if he answers these charges at all. Actually the truth lies somewhere between these two attitudes, for mobiling at these frequencies is altogether unlike operation in any other region of the amateur spectrum.

Where it all started

When VHF'ing was in its infancy scarcely twenty-five years ago, a few thoughtful tinkerers gathered together in various sections of the country to ponder a problem. How could these "experimentalist" frequencies be effectively employed for ham communications? Numerous tests had been conducted on VHF, but they had always been point-to-point affairs, and always prearranged. Results, published periodically in *QST*, substantiated the theory that 5 meters could afford amateurs something truly different, provided enough interest could be aroused. What these ambitious amateurs undertook was the construction of crude mobile rigs, many using single-tube crystal controlled transmitters and super regenerative receivers--others used tuneable converters and modulated oscillators, for operation on this "unexplored" band. Well documented in ham journals is the fact that these famed 5-meter mobiles were directly responsible for VHF coming into its own as an essential yet independent adjunct to the hobby.



For K2UYH, a frequent extension of mobiling is hilltopping, which is where our camera caught him recently. Antenna is a 32-element 144 MHz collinear, while at left (barely visible) is his 3-element six meter collapsible. Normally halo antennas are employed for in-motion QSO's.



Night time transmitter hunts are a favorite indulgence for anyone equipped for six or two meters during the summer. This photo was snapped during a Portland, Ore., hunt a few years back. (Hidden transmitter is 10 feet to the right of the antenna, well camouflaged in foliage).

Soon more sophisticated equipment began to appear, with superheterodyne receivers and higher-powered transmitters. The magazines encouraged the trend by publishing new circuits as they were developed.

By the early fifties the 6-meter band had emerged as a full-fledged extension of 10 meters, while war surplus gear put operators on 2 inexpensively. Civil Defense, no longer content to see all this going to waste, shifted its entire emphasis from 28 to 144 MHz. Literally thousands of cars sprouted whips, many equipped inside with Gonset Communicators purchased by CD. In 1952 the FCC passed an amendment permitting Technician Class ticket holders operation on six. Overnight signals appeared, bringing the 50 MHz band from relative obscurity to a mobileer's holiday. The "Mobile Sixers" was founded in Philadelphia while similar groups organized simultaneously from coast to coast.

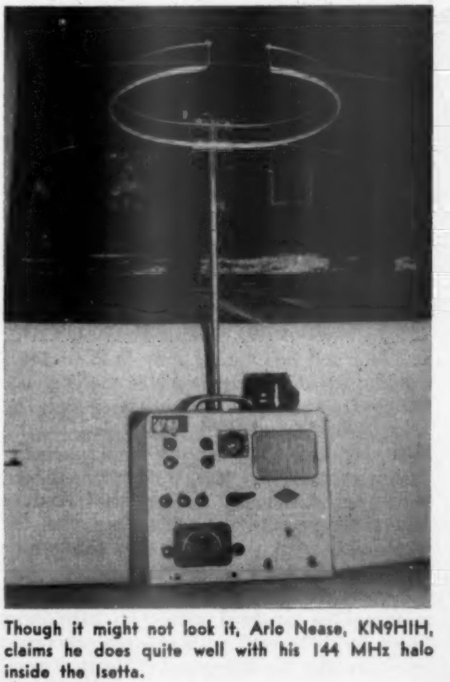
What is significant about this recent history is that without mobile participation and pioneering, these two VHF bands could hardly be what they are today. Additionally, the very highs developed in a reverse fashion from the lower frequencies, where base stations were initially what populated the ham bands. Why this extraordinary enthussiasm for six and two meter mobiling?

Perhaps because it *is* different.

144 MHz techniques

Because VHF mobiling is something unique in our hobby, to enjoy maximum success requires a bit of first-hand investigation. As many know only too well, you can't just put together a set that tunes 145 to 146 MHz, hook into the car radio antenna and expect results. Nor for that matter can you expect to install a vertical radiator on the bumper and start calling CQ on 50.78 MHz. Unless, perhaps, you live in northern Vermont.

At two meters, particularly, it is to your advantage to check local operating habits. The mobiles with the greatest number of QSO's are often those who belong to an on-the-air club or emergency network such as AREC. Why? Because base stations in many sectors are horizontally polarized, while mobile enthusiasts stick to their whips. To reach a happy medium necessitates



Though it might not look it, Arlo Nease, KN9HIH, claims he does quite well with his 144 MHz halo inside the Isetta.

A crowd always gathers around W2FNM's fire-engine-red Model A, "equipped for the works" (160 through 2 meters).

getting together with an active local and finding out his views on the subject.

Mobiling here can afford numerous short-range contacts providing a few basic facts are kept in mind. Most importantly, nearly all two meter stations are still crystal controlled. And they don't tune the entire band after each CQ. For you, it might seem like a small feat, but for a well-equipped base station it can be a physical impossibility to tune 144 to 148 MHz in anything short of ten minutes. For this reason it is a good idea to have several crystals handy if you're at 144.4 and he's tuning only "145 to 146."

Although 95% of two meter stations use AM, certain regions are populated only by hams using converted Motorolas, Links, GE's, etc. (all FM). By the same token the vertical/horizontal observation mentioned above can frequently be reversed! And to add to the confusion is the fact that the most-used frequencies in the band may vary from one state to another.

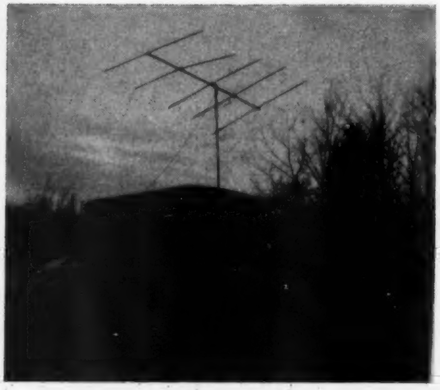
Dependent on whether you reside in a metropolitan or rural area, you can sometimes do quite well with super regenerative receivers like the still-popular Heath Twoer. While it may not be a dyed-in-the-wool v.h.f. DX'ers cup of tea, the super regen remains one of the most sensitive designs available, providing excellent reception in low-activity regions.

The "real" 2-meter mobile addict uses three antennas: a 19" whip, a single-element halo, and a collapsible 5-element yagi. Generally the whip and halo are interchangeable at the rig, while the yagi is for hilltopping. The more typical setup, however, is simply either the halo or whip.

At 144 MHz, height is an all-important factor. A good technique to employ when seeking a QSO is to begin the CQ while driving up an incline, such as the side of a hill or bridge ramp. Time your transmission so that your sign-off coincides with the peak of the hill or bridge. In reality this method inflates your signal several "S" units, just enough to catch another station. Once in contact, you'll find you can hold it satisfactorily even though you lose elevation. Since the other station invariably has a directional antenna, *he* does the work.

Here's a shot of the author (about four cars ago) making comparison checks between a Clegg Thor 6 prototype and a 99'er. A 50 MHz linear amplifier in the trunk, remotely controlled from the dash, aided immeasureably in shortening the life-span of this '53 Chevy.

Another "must", while we're talking about narrow beamwidth antennas, is always to give your location. Nothing is more frustrating than to hear a mobile calling CQ, not know his QTH, and begin turning the antenna only to have him go off while you have him in a null. A good rule-of-



Although mobile-in-motion QSO's are understandably short-lived, WA2VOI really racks up on mountaintops during VHF contests.

thumb here is that one location report with each identification will buy you what it would take three CQ's to secure otherwise.

Obstructions can be severely damaging to a 144 MHz mobile signal, since most *rf* reaches the base receiver by direct groundwave. Don't call CQ while trapped in downtown traffic between skyscrapers, or under an elevation. Unlike the lower frequencies, your S7 signal can virtually disappear in a matter of seconds. If you find that you'll be losing elevation soon, or that you'll be stuck under an overpass at a light, inform the other operator. He'll be only too happy to either kick in his preamp or stand by until you are in the clear again.

Flutter can be annoying at 2 meters if not approached properly. Rapid QSB can result from cross polarization (a common offender) and/or your fast-moving vehicle. But the most little-known cause that can be remedied easily is simply your car's position. Since wavelengths at two meters can be measured in inches, your proximity to metalic objects and buildings sharply affect your signal. If you are stopped and in QSO, inch the car slowly backwards or forwards while listening to the receiver. Always park exactly where the signal peaks if at all possible. Use this technique at stoplights also by prematurely slowing. When you see the signal begin to rise on the meter, take her forward by the inch. You may find this changes your driving habits considerably, but it is well worth the effort.

In open country two meters is loads of fun. By closely observing the "S" meter, you'll experience a phenomena seldom found at any other frequency. Buried pipelines, hidden rock formations and underground streams often inflate incoming and outgoing signals by as much as 45 db. The trick is finding the exact spot. When located, you can park, call CQ and wait for the pile-up. This is almost as much fun as mountaintopping, and even more when you inform your captive that you are 40 miles away, running 3 watts and practically at sea level.

The formula is all in keeping the receiver "on" whenever you take a drive. If you are out with the wife and kiddies, keep a watchful eye on the meter even though the volume is turned down. Make a mental note of your location should you see any sharp increase in signal strength that disappears rapidly as you pass. Then, when you are out alone, return to that spot.

Can you get real DX on two without heading for the hills? Certainly, but it takes some doing. By employing the same method outlined above, watch for sudden *and sustained* increases in signal strength in your high-speed driving. For example, a drive on the Pennsylvania Turnpike might net nothing, or the time of your life. It's worth keeping the rig on to find out. Should you get "caught" in a situation where you notice strong signals from an area you know to be unusually far away, pull over to the side and attempt your QSO. Don't continue on your way, for you've accidentally fallen into a *VHF* phenomena known as the "tropo duct." Like a pipeline, 144 MHz mobile signals can be "ducted" into certain towns up to 200 miles away for periods of time lasting only a few minutes to two hours. The peculiar thing about this condition is that stations five miles away won't hear a peep.

One final tip: If at all possible, install a SWR bridge in the feedline and mount it under the dash with your transmitter. Two meters is the only popular ham band where you'll be making a 2 MHz frequency jumps as a matter of course, and you'd be surprised what that will do to your standing waves! Cut the antenna for the middle of *your* operating range and arrange a tuning device for emergencies. More 2E26's have been blown by two meter mobileers than you'd care to learn about.

50 MHz techniques

On six, the old "there's-something-for-everyone" adage is a fact, if you are prepared for it. Fifty megahertz mobiling has been termed a cross between 10 and 2 meters. Don't you believe a word ot it.

In reality six meter monitoring can be compared with no other. It's characteristics resemble no known amateur band; nor do its problems. Perhaps the most pressing annoyance is ignition noise, the cures for which have appeared in all major ham publications. Though not as severe as on the lower frequencies, this problem must nearly always be dealt with before you'll enjoy the true excitement and rewards of six meters in the car. Once this is out of the way, you'll want to spend 20 minutes with a coil of #12 wire and a trimmer capacitor to place a series tuned circuit across your generator. Careful adjustment with an eye on the "S" meter and the engine at full rev will null out your generator whine and you are ready for action.

Unlike two meters, you *will* need more than a few crystals, unless you have a well-regulated 8 MHz VFO handy. Putting yourself on 50.106 can be a tragedy or a blessing in disguise, depending on the weather, time of day and local whims. Most mobileers prefer the 50.200 to 50.500 range, although there seems to be an unwritten philosophy which says that the first operator on 50.250 won't be lonesome. But even this won't help you on a Saturday night or during a band opening, at which time you had better be either on a very high mountain or above 50.750 MHz. Confusing? The best is yet to come.

"Normal groundwave conditions" is a misnomer; one day you will get an S7 report from across the river, the next day an S5. Though your customary working radius is greater than on 144 MHz, it isn't necessarily as dependable. A multitude of variables such as humidity and temperature can drastically alter your average-range picture. To say nothing of Sporadic-E skip, which, depending on whom you consult, either extends or shortens your groundwave coverage.

The most noticeable difference, though, between mobiling on two and six is your calls-QSO ratio. Since few people really tune on six meters until after they've first checked their frequency, your calls-QSO ratio is directly proportional to your *proximity to him on the dial.*

A comparatively recent development, the Cush Craft "Squalo" has a loyal mobileer following among many six and two meter operators. The antenna, essentially a "square halo", affords an omnidirectional dipole pattern with compact physical dimensions and is available in models through 432 MHz.

But aside from these relatively minor calamities, you can have enough fun to write home about. When you find the neighbors XYL, and junior op's too much with their TVI complaints, you can delight the entire crew by hopping into the auto and steathily driving off to a new, unsuspecting sector, wreaking havoc as you cruise by. Which, incidentally, might be one of the contributing factors in the tremendous popularity of 6-meter mobiling in this country.

Operationally, it is advantageous on 50 MHz to first check your frequency (a spotting switch is a "must"), and then let loose with a CQ. Due to the concentration of stations in the first 500 kHz on this band, it is seldom necessary to call for more than one minute before tuning. A rapid check of the band thereafter, followed closely by a more careful tune, is also a good habit to get into. Never make a transmission without stating your approximate location unless you are a commercial radio announcer who likes to keep in practice during off-hours.

Unlike two, a good number of 50 MHz stations enjoy working weak-signal mobiles and attempting to hold them until the bitter end. This is important to bear in mind because you can unintentionally offend these long distance runners if your ignition noise overrides their calls, or if you are not in the habit of listening for threshold signals.

Another tip: Since most of your QSO's will be with well-equipped base stations, don't drag out your transmissions. He can

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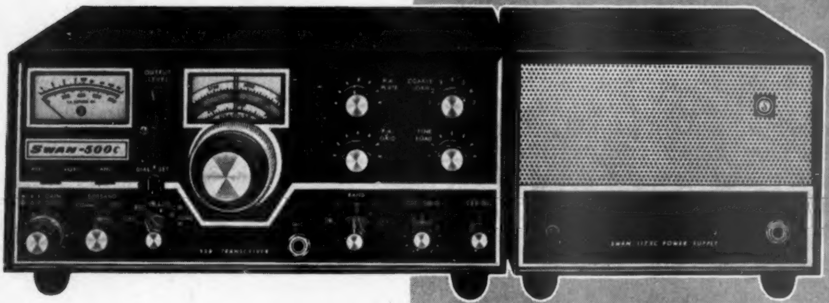

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ASK THE HAM WHO OWNS ONE

hear signals you can't, especially those on your frequency. If you find you have lost contact, standby for instructions. Chances are you'd fare better higher up the band, where QRM is not as prevalent. This technique can also be employed in reverse. To secure your QSO, give a call in the first 100 kHz of the AM band, establish contact, then QSY without waiting for the inevitable heterodynes.

Although only the rank newcomer to six meter motoring will have to be told that 95% of the stations are horizontally polarized, few recognize that installation of a CB-type whip can also be advantageous. Quite often switching to vertical polarization yields unsuspected rewards, particularly if your partner can do likewise when you are stuck on a busy frequency. If you're handy with plumbing, add another loop to a 3-ring halo and listen to the praise roll in. The additional ring, when the antenna is carefully adjusted for best-height-above-ground, frequently eliminates the "typical mobile flutter" that's usually a dead giveaway to operators who don't like mobiles.

If you would really like something different, the next time signals take on that warbly aurora characteristic, head for the highest piece of land around and rotate the auto for a peak reading. Pick out the strongest CQ caller you hear, speak noticeably slower and more distinctly, and give him a shout. The old rule-of-thumb that you must have at least 100 watts into a 5-element array can be proved wrong if you are the persistent type.

The simplest way to pick up DX on six is, of course, through Sporadic-E skip openings. Big antennas and high power mean little. The trick is to get out of the QRM. Make it a practice to always keep a crystal for an odd frequency above 51 MHz handy for emergencies. It is a fact that mobiles invariably cash in first on long-haul skip contacts, probably because a six meter mobileer tunes a receiver with less bandspread than the base stations employ and therefore is one of the first to hear the higher frequency DX callers. Keep transmissions short, since E-layer openings are unpredictable and can take a turn for the worse in an instant.

The really ardent 50 MHz mobile operator employs both a v.f.o. and a nuvistorized preamplifier. Properly regulated supplies for stability and multiple-wavelengh feedlines for best SWR make for mobile fun you'd never dream possible. By spending 90% of my driving time *listening*, this writer picked up 34 states during a 6-month period not long ago, which, by the way, included five over-200 mile groundwave QSO's. This was accomplished with a 4.5 watts-output transmitter into a 4-ring halo.

Driving through open country, keep an ear out for the weak, out of state signals. If you hear a couple stations in QSO whom you know must be at least 75 miles away, throw your carrier on intermittently to create a "signaling" heterodyne. When they stand by for the breaker, do your stuff. If you've been listening for a while, instruct them *right off* to turn their yagis NNE, or whatever the approximated direction is. They'll never believe you're a mobile.

Be Different

We would be doing you a grave injustice if we did not include in this report the fact that numerous v.h.f. stations simply will not QSO mobiles. Their reasons are worth listening to, if you are seriously contemplating mobile operation: (1) They disappear into the noise before you've had a chance to make a transmission, or (2) They never say anything worth listening to, or (3) Their audio is inferior, or all three. There is much truth in these observations.

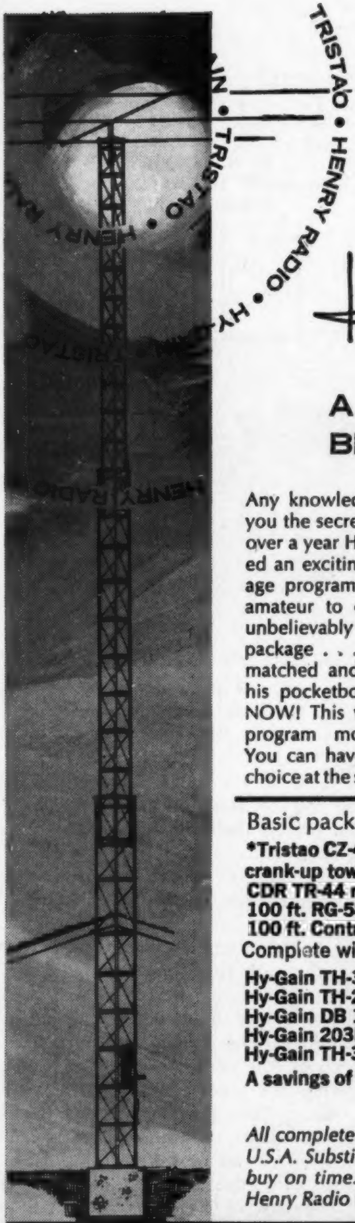
We can't stress often enough that you keep your transmissions *short* and to the point, seldom more than two minutes in duration. Let him do the talking; anyway, you have to drive.

Avoid confining your topics of conversation to such earth-shattering developments as a Mack truck has just pulled in front of your vehicle. Keep a scratch pad on your dashboard and *use it* to note what *he* is interested in.

If your audio really delivers, the other station won't care if you are an S1 on the meter. If it doesn't, invest in a CB-type transistorized speech clipper or compressor. They work, you know and are just about the best buys around.

By "being different" you can win over a lot of these soreheads, realize many hours of pleasureable mobiling, and have something you'll remember for a long time as truly worthwhile hamming.

. . . K2ZSQ



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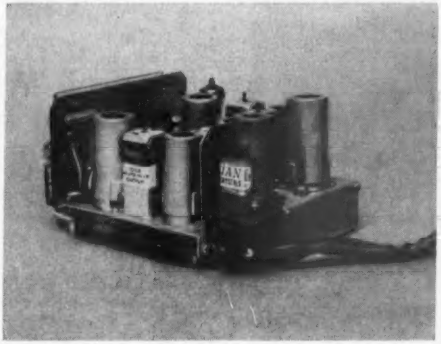
Looking at the receiver section, either out of the cabinet or at the diagram (if you are lucky enough to have one), we find several stages of six MHz *if*. If we make one of these stages a mixer and change the last two *if* cans to 455 kHz, we have a fine double conversion receiver. By adding crystal controlled local oscillator to our new mixer stage, we are in business. This local oscillator may be added as an outboard stage mounted on a bracket next to the pre-amp on the back apron of the receiver section as shown in Fig. 1.

The choice of oscillator tube may vary. I used the 6AV6 because it was on hand and has shown to work fine.

The bracket should be made and mounted in place before any wiring is done due to the difficulty of getting the mounting screws in place after the wiring is in. The oscillator is then wired as shown in the diagram and test voltages applied. Using a VTVM you should read about −2 to −4 volts at pin one of V11 (6BH6) which is our new mixer stage.

Now remove the last two 6 MHz *if* cans (T3 and T4) noting the position of the green dot on the bottom of the existing can so we can place the new ones in the exact position. Remove the wiring from the old *if* cans carefully so as not to shorten the leads any more than absolutely necessary.



This photo shows the oscillator mounted next to the pre-amp on the back apron of the receiver section. One of the new 455 kHz *if* cans can be seen in the center.

These leads will be used on the new 455 kHz *if* cans. I used the Miller "K TRANS" designated 12C1 and 12C2, input and output, since they are of the same size and mounting configuration as the ones being removed.

When the transformers are mounted and reconnected, the cathode resistor (R21) on our new mixer tube should be replaced with a 5 K resistor of the same wattage as the old 150 ohm one. This completes the conversion so check the wiring carefully.

Next, leaving the receiver section out of the case, connect the power plug to the transmitter modulator audio section and begin the line-up of our new *if* section.

When you turn the set on, don't be alarmed at the lack of VHF hiss that you are used to hearing. This will be back when the new *if* transformers are peaked. This can be done either on background noise or by using a noise generator. This process is described in all the handbooks, but it is sufficient to peak to the highest noise level.

When this has been done, you might be

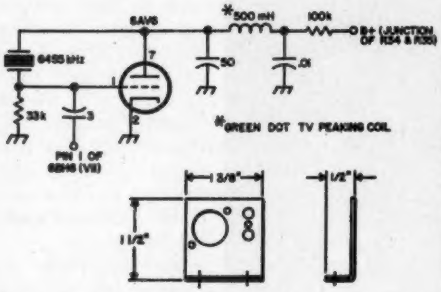


Fig. 1. The oscillator circuit showing the mounting bracket used.

interested in one other modification using low cost rectifier diodes. The replacement of the two 6X4 rectifiers in the power supply with solid state will yield about 25 volts more from the output of the supply and will eliminate a good deal of heat.

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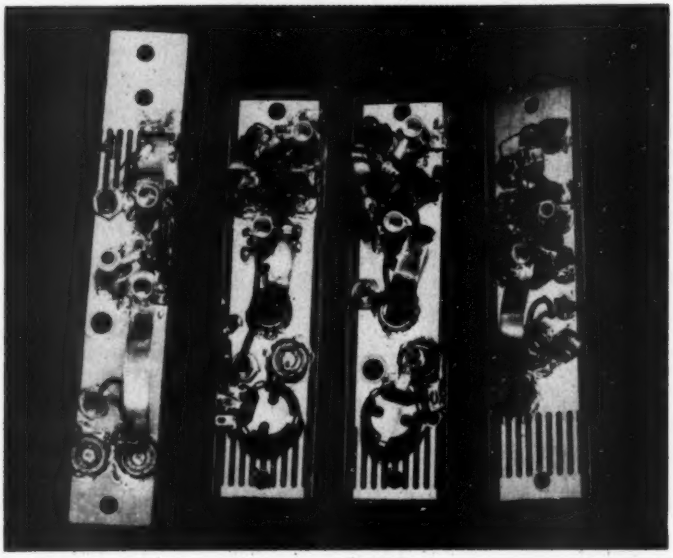

Frank C. Jones W6AJF
850 Donner Ave.
Sonoma, Ca. 95476

432 MHz Amplifiers

The four different 432 MHz amplifiers, shown in the photograph and in the circuit diagrams, were built up on small strips of copper plated plastic board. The purpose was to run a series of tests on different kinds of FET units which might work on 432 MHz. The field effect transistors have come down in price and the three types tested all sold for approximately one dollar each. The three available at the time were the Motorola MPF 102, the Texas Instrument TIS34 and the Union Carbide UC 734. Both grounded-gate and neutralized grounded-source circuits were tried by either making up new strips or rewiring the existing strips. The four amplifiers shown in the photograph from left to right are ground-gate MPF 102, grounded-source TIS34, grounded-gate UC 743 and grounded-source UC 734 (or 2N4416).

The circuits consisted of short pieces of copper sheet from ¼ to 5/16-inch wide; 1 to 1½-inches long for the tuned input and output 432 MHz circuits. Low priced plastic piston trimmer capacitors of 1 to 6 pF were used to tune the circuits. These were connected by short leads, usually sheet copper, to the input and output terminals of the transistor sockets. In most cases a small copper shield was soldered across the socket to isolate the input and output circuits. The grounded-source terminals required at least two 300 or 500 pF disc capacitors with extremely short leads from socket to ground in order to "cool off" the rf stage in spite of a slug-tuned neutralizing coil. The latter had to be from 2 to 4 turns on a white-coded ferrite slug form, 3/16-inch diameter for the different FET units which ran from ⅜ to 1⅜ pF feedback capacitance. The coil and leads had to resonate with this capacitance to 432 MHz. It was later discovered that the neutralizing coil-form mounting screw should not be grounded since this makes it difficult to obtain correct input, output and neutralizing adjustments. Also, an insulated mounting (in the input compartment) allowed one more turn of wire on the form with wider bandwidth in the adjustments.

The 50-ohm input connection for either grounded-gate or source circuits at 432 MHz always seemed to work out at about the center of the input strap circuit, that is midway between the tuning capacitor and ground ends of the strap. Apparently both types of circuits functioned at best noise figure with from 200 to 500 ohms impedance into either the gate or emitter terminals. The same circuit showed lower Q (less critical tuning) with emitter input, that is with the grounded-gate connection. This probably meant about 200 ohms input, whereas gate input needed around 500 ohms for best NF.

The output circuit was always adjusted for 432 MHz resonance, maximum gain, together with space variation of the output loop. Too close coupling gave low stage gain. The output loop from coax fitting to ground was made of number 18 wire in order to be able to vary the coupling to the drain tuned circuit, but, at the same time, to keep the coupling constant when in use as a preamplifier ahead of the regular 432 MHz converter.

The neutralizing coil in the grounded-source units was adjusted for the value which gave maximum gain without excessive regeneration in all cases. Actual rf oscillation even 2 or 3 MHz away from 432 MHz had to be checked by tuning the *if* receiver across several MHz since this will prevent proper operation of an amplifier. Noise figure and gain measurements were made on all amplifiers using several different transistors of the same FET types. A diode tube noise generator, partially compensated to work reasonably well at 432 MHz, was used for NF measurements. A standard signal generator with a 6 db UHF attenuator between the amplifier and signal generator output connector was needed to insure 50-ohm input impedance, and another similar attenuator was connected in the 50-ohm line between the preamplifier and the 432-MHz converter. The latter helped reduce regeneration in either the amplifier or the converter from spoiling the gain measurements.

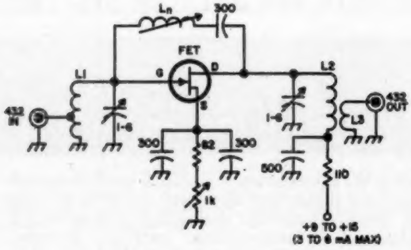

Fig. 1. Grounded source circuit for FET's.

L1 = 1" long x ¼" wide copper strip, center tapped.

L2 = 1½" long x ¼" wide copper strip.

L3 = Approx 1" of #18 wire coupled to L2.

Ln = 2-4 turns #22 wire ¼-⅜" long x 3/16" dia.

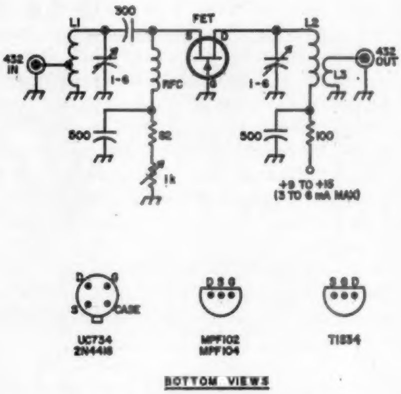

Fig. 2. Grounded gate circuit for FET's.

L1, L2, L3 as in Fig. 1.

RFC = 7" of #22 wire coiled up into solenoid.

The MPF 102 (also some MPF 104s) amplifiers gave very low gain figures ranging from 1½ to 2 times or about 4 to 6 db. The noise figures ranged around 7 or 8 db which wasn't too bad. The converter by itself had a NF of 3 db with a Union Carbide 2N4416 rf stage, a very hot five dollar FET unit. The UC 734 FET units are TO-18 metal-cased units with four leads exactly like the 2N4416's except that they are mass produced without the many added factory tests made on the 2 N4416's. Therefore, the UC-734 costs about one-fifth as much—$1.10 in small quantities.

The TIS34 neutralized amplifier showed about 4 to 5 db for the best plastic cased units in the grounded-source circuit and with gain figures ranging from 6 to 8 db for the best units. There wasn't too much variation in units, with over 50% working very well at 432 MHz. The TIS34 grounded-gate amplifier was quite stable, required no neutralization and gave a NF of around 6 db and gain of 4 to 6 db. This type of circuit would be fine for a second rf stage in a converter with a "neutralized" grounded-source first stage, since two "neutralized" rf stages always seems to be full of oscillation problems. These TIS34 plastic units and the MPF 102 plastic units look similar but have different lead arrangements. Both require an in-line socket with three terminals, if a socket is used. A socket increases lead lengths and capacitances but sure saves time in comparing transistors of the same make. Unfortunately, the TIS34 seems to be hard to find at Texas Instrument distributors and outlets.

The UC 734 units, if selected for 432 MHz operation, were by all comparisons far superior to the other FETs. The gain figures ranged from 8 to 12 db in grounded gate, with NF of 4 to 5 db. Twelve db was the highest measured in a run of ten UC 734 units. About 50% were good for 432 MHz with 3 of the 10 being "red hot", fully equivalent to the best of the four 2N4416 units available for these tests.

The neutralized grounded-source UC 734 selected units gave NF of 2½ to 3 db and gain figures of 10 to 18 db. These amplifiers are a marvelous thing for weak signal 432 MHz reception. It takes a very good parametric amplifier with its tricky adjustments and high cost to do any better. Needless to say, these tests were time consuming since each change of transistors always seemed to require a little readjustment to arrive at best gain and NF. Usually best NF occurred at 3 to 5 mA drain current with a 9-volt battery supply. The source bias voltage should be higher for 12 or 15-volt supplies, but probably at these same current values, since FET units are quite a bit like tetrode tubes.

In conclusion, the Motorola MPF 102 units are not very good at 432 MHz since this is too high a frequency for these general purpose rf and *if* transistors. They seem to be readily available at the larger Motorola dealer outlets at present for 90¢ to $1 in small quantities. The Texas Instrument TIS34's are fine at 432 MHz but at the time of these tests, are difficult to find at TI outlets (priced about $1.10 each). The Union Carbide UC 734 units, if selected, are real fine transistors for 432 MHz. These little gems are replacing all other transistors in my converters since they are far better than the best bipolar transistors that I've been able to obtain. At the time of these tests single UC 734's were $1.10 and about 75¢ in quantities of 100 and in very good supply. The poor ones at 432 MHz were all less than 2 db NF at 144 MHz, so none were wasted!

. . . W6AJF

**The specifications for I_{GSS}, I_{DSS} and g_m are relaxed slightly; capacitance and frequency specs are the same as for the 2N4416. ed.*

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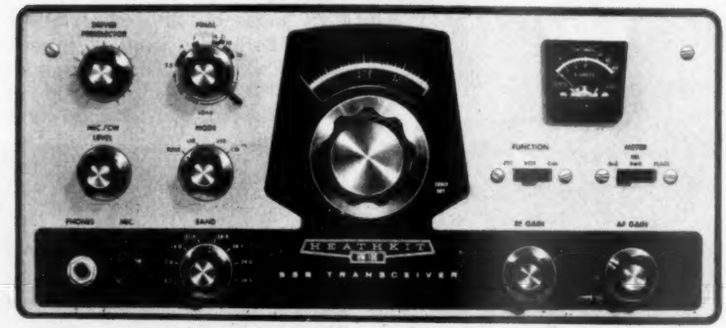

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Quick Converters

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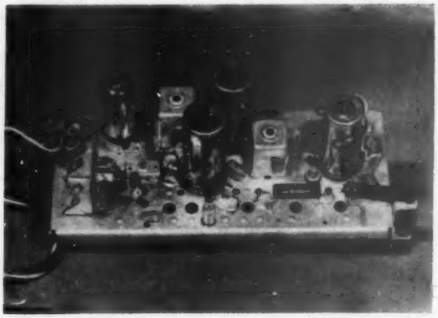
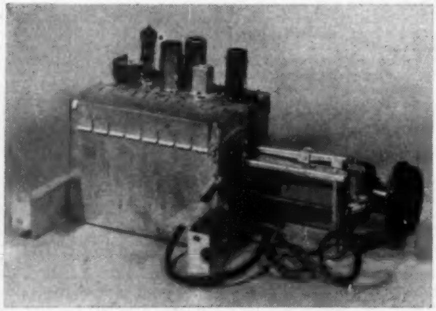
Recently I wanted to listen in on two meter activity, preparatory to going mobile. In order to do this I needed a converter to use with one of my station receivers. Naturally, I wanted it in a hurry and at minimum cost. A review of the ham magazines and handbooks disclosed several designs for good looking converters but any of them would have required mail order parts and considerable construction time. My next move, of course, was to open a catalog and price the commercially-made gear. The fine print associated with most of them said, "Specify *if* Frequency", indicating that they might not be on the dealer's shelf but made to order. So I asked myself, "How can I get one *now?*"

After thinking about this one for a while I realized that the front end or tuner in every TV set is essentially a converter. I immediately began to disassemble an old TV set that I had been saving for parts salvage and I found a very promising tuner. Incidentally, a few weeks later I made a trip to my friendly TV dealer to see what the "market" might have to offer other hams. I learned that used TV sets, in whole or in part, can sometimes be had for the asking. In fact, I came away with a twin to my first tuner.



The circuit deck as it appeared before the removal of the fine tuning assembly, power wires, and the 300 ohm input jack.



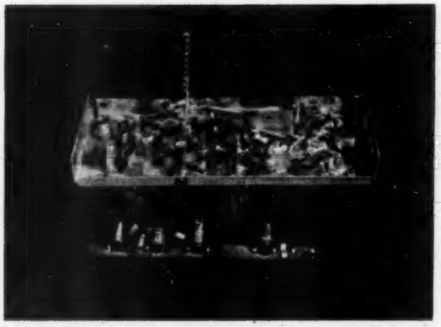
This is the way the tuner looked as it was removed from the TV set. It covered 16 channels, VHF and UHF.

As soon as I had scrounged the first tuner I did some research into the industry standards for TV channels and the associated receiver design. I learned that TV broadcast channels are assigned in four segments of the radio spectrum that lie between 54 and 890 MHz. Each channel occupies a total bandwidth of 6 MHz. The picture carrier is 1.25 MHz above the lower band edge and the sound carrier is 4.5 MHz above the picture carrier (0.25 MHz below the upper band limit). The current practice in the industry is to arrange the TV set tuner to convert the incoming TV signal to the receiver's nominal i.f. frequency of 41 MHz. (A few tuners may still be found that have an *if* at 21.5 MHz.) This is accomplished by operating the local oscillator 41 MHz above the upper band edge. The following relations exist:

Channel number	Occupied r.f. band	Picture Carrier	Sound Carrier	Tuner Local osc.
2	54- 60 MHz	55.25	59.75	101
3	60- 66 MHz	61.25	65.75	107
4	66- 72 MHz	67.25	71.75	113
5	76- 82 MHz	77.25	81.75	123
6	82- 88 MHz	83.25	87.75	129
7 to 13	174-216 MHz	*	*	221-257#
14 to 83 (UHF)	470-890 MHz	*	*	517-931#

*The carriers have the same relative positions in each of the channels.
#At intervals of 6 MHz.

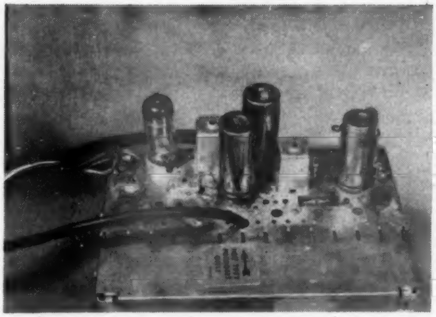
The frequency of a signal at the output of a tuner or converter is equal to the *difference* between the frequency of that signal and the frequency of the local oscillator. (The sum of the two could be used but that would usually result in an inconveniently high frequency for use in receivers). Note that with the local oscillator *above* the incoming signal, the output of the tuner is inverted. That is, with two signals coming into the tuner, the one at the higher frequency will be translated to the lower of the two frequencies at the tuner output. At the tuner output, each TV channel will occupy a 6 MHz band extending from 41 to 47 MHz; The picture carrier will be at 45.75 MHz and the sound carrier will be at 41.25 MHz. Other signals may also be present as most tuners have a bandwidth of at least 8 MHz; both adjacent-channel and image signals will be present. Two other points are significant: The *if* transformer(s) in tuners are designed as broadband devices and will remain so even though you attempt to peak the primary and secondary windings at the same frequency. Most tuners make no attempt to amplify incoming *rf* signals in the UHF band, utilizing from one to three tuned circuits as a bandpass filter between the antenna and the mixer.



The rf coils are shown cemented to the chassis. One of the original channel tuning strips is shown for comparison.

Designing the converter

Two decisions that will have to be made regarding the converter involve the amateur band that you want it to accept and the frequency range that you want that band to have at the converter's output. Operating convenience will be greatest if the output frequency bears some direct relationship to that of the band on which the converter is used, for example:



Outwardly the tuner/converter shows only a little change in its interim state.

Amateur Band	Bandwidth	Convenient converter outputs
21.-21.45 MHz	0.45 MHz	X.00-X.45 MHz (X = any whole no.)
28.-29.7 MHz	0.70 MHz	8.0-9.7 MHz, 18.0-19.7 MHz
50.-54. MHz	4.0 MHz	10.0-14.0 MHz, 20.0-24.0 MHz
144-148 MHz	4.0 MHz	4.-8. MHz, 14.-18. MHz, 44-48 MHz*
220-225 MHz	5.0 MHz	10-15 MHz, 20-25 MHz, 40-45 MHz*.
420-450 MHz	30.0 MHz	See text.

*If your receiver will tune over this range you will not have to modify the i.f. transformers before use.

The converter output frequency should be chosen to fall within the tuning range of your receiver, should be covered without switching bands, and preferably without tuning the receiver across any strong local stations. The outputs listed above assume that you will use a fixed local oscillator in the converter. If a variable local oscillator is used, you might want to consider a conventional *if* frequency such as 10.7 MHz, for which commercially-made transformers are available, or 4.5 MHz, and use the sound *if* transformer from the TV set. If you plan to use the converter between 420 and 450 MHz then you can cover the band in segments by employing a fixed local oscillator and a broadband *if* or you can make the local oscillator tunable across the entire band and use either a broad or a narrow *if* system at any convenient frequency.

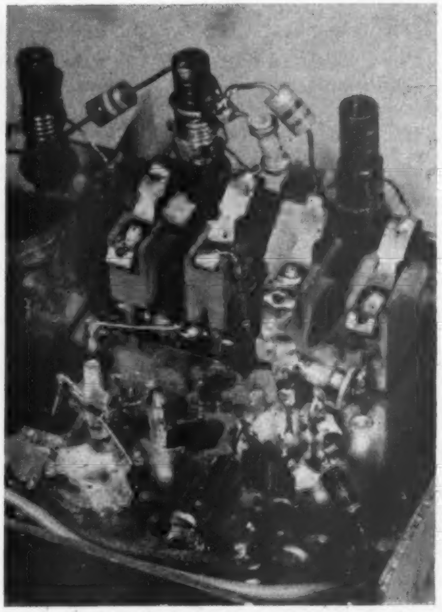
As indicated above, you will have a choice of using either a fixed or a variable local oscillator; you may also elect to use either a narrow or a wideband *if system.* Your decision will depend on the band you want to cover, the tuner that you are converting, and your station receiver. Several combinations are possible. I won't attempt to describe them all; it will be more helpful if I show how I made my decisions.

The two meter conversion

My objective was to build a converter to receive the range of frequencies from 144 to 148 MHz. One of my station receivers (an ancient S-36) would tune from 27 to 144 MHz in three bands. I studied the tuner that I wanted to convert. I found that it employed a 6BQ7A cascode *rf* amplifier and a 6S4 local oscillator, both of which fed a 1N82 crystal mixer. The mixer was followed by a second 6BQ7A *if* amplifier which also used a cascode circuit. A 6S4 was used to stabilize the plate voltage supply to the local oscillator. Taken all together it made an excellent line up for use as a converter.

After studying the tuner's construction and its schematic diagram I decided on the following course of action: I would retune the *if* transformers higher in frequency by 2 MHz (from 41-47 MHz to 43-49 MHz) and I would use a fixed local oscillator working at 100 MHz. This would result in the two meter band being converted downward by an even 100 MHz and the frequencies coming into the receiver would be directly related to their position in the band. For example, 144.5 MHz would become 44.5 MHz, 147.3 would become 47.3, etc. It was at this time that I decided to eliminate the existing fine-tuning mechanism, change the input from a 300-ohm balanced to a 50-ohm unbalanced configuration and to use 300-ohm twinlead to connect the converter to the tunable receiver. I noted (for future reference) that this particular tuner provided no amplification on the UHF bands. I also discovered that normally active overtone crystals would oscillate if connected in place of the local oscillator coil.

It was less than an evening's work to disassemble the circuit deck and the coil turret to the extent necessary. My plan was to get filament and plate power from the tunable receiver. This was done by making up a cord and plug to match an octal socket that was provided on the receiver for the connection of external power. I discovered an idle contact on the socket and found that it could be used to make the receiver's agc voltage available to the converter. I suggest that if you do not do the same thing, you may want to provide some sort of bias voltage for the converter. Most of them require a bias voltage of from −1 to −3 volts; it is usually supplied by the TV set's agc system.



The rf mixer and oscillator coils are shown supported by their leads near the tube socket. The mixer diode is visible through a hole in the chassis.

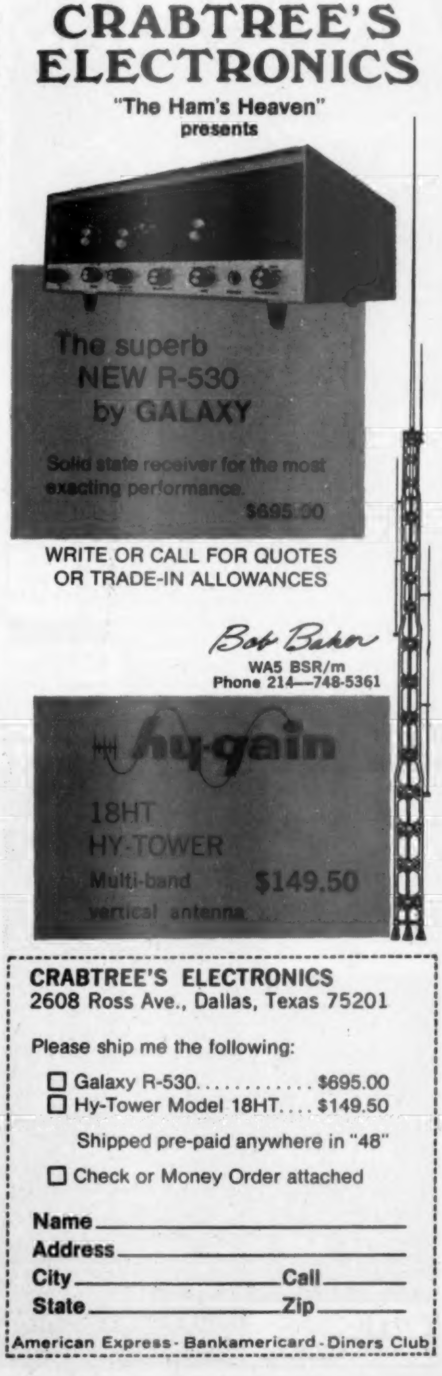
I also removed the assemblies of fingers that made contact with the channel strips in the turret. I found that one of them had to be left in place, however, because the mount for the mixer diode was an integral part of it.

In the second evening I was able to replace the *rf* coils so as to put the converter on two meters. The first operation was to remove the local oscillator coil from the tuning strip for channel #2. It normally works at 101 MHz and so it could be used without change. The tuning slug in the coil will easily change the frequency of the circuit by the required amount. Next I removed the *rf* coils from the tuning strip for channel #7 (174-180 MHz); they were soldered in place and adjusted to resonate in the two meter band. A grid-dipper was a big help in that work. Positioning the coils the way that they are shown permits them to be adjusted with a tuning tool inserted in the normal way from the top of the chassis. The final step was the connection of the input and output leads and the connection of the converter to the receiver. The *rf* coils peaked rather broadly, of course, but I was pleased to find that I had a working converter that had a noise figure in the range of 6 to 7 db and a voltage gain of over 90. During the several weeks of operation that followed, my only criticism of the converter was that the local oscillator frequency was affected by mechanical vibration and that the whole assembly lacked the finished appearance of commercially-made equipment.

Gilding the lily

As indicated above, I originally went into this project with the idea that I was building a temporary piece of apparatus. The initial results convinced me that with a little more work I could have a converter that would be a permanent asset to my station. I considered such improvements as a crystal oscillator and *rf* coils made from commercially-built inductor stock. A crystal at 33.33 or 50.00 MHz could easily be obtained but I was concerned about having to filter out all but the 100 MHz harmonic from the mixer if I was to avoid spurious responses in the receiver. I also decided against high Q inductors as they might result in too narrow a bandwidth to cover the entire two meter band.

The finished tuner/converter presents a fairly respectable appearence. What was formerly the rear has become the "business end."



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My final decision was to use the *rf* coils from a channel tuning strip for channel #6. These coils, together with the local oscillator coil, were cemented directly to the chassis to improve the converters frequency stability. The coils were brought to resonance by removing several turns from each one. I found this to be easier than using the coils for channel #7, as described earlier. The flexible contact fingers were broken off their supports and the coil leads soldered directly to the rivets that had secured the fingers. A type "N" coaxial connector was mounted on the chassis to function as an antenna input jack. One of the FM band rejection filters, previously removed from the 300-ohm antenna input circuit, was connected between the input jack and the antenna winding on the *rf* input coil. I also changed the 43 MHz output lead to coax, terminating it in a plug that would mate with the antenna terminals on my receiver.

The original power leads had been connected to an exposed terminal strip on the top of the chassis. I removed the terminal strip and ran a four conductor cable into the chassis through a rubber grommet. The free end of the cable was terminated in an octal plug that was arranged to mate with the "external power" socket on the back of the receiver, picking up heater, plate and agc voltages. I recommend my approach to anyone who wants a converter in a hurry or would like the pleasure of building something worth while out of practically nothing. My cash outlay was exactly zero, since all of the required cables, plugs, etc. that were not a part of the original tuner came out of my junk box.

I find that there is a pretty fair amount of activity on two meters around Chicago right now, but I wonder what the gang are doing up on 420 MHz. Lets see now; I still have that second tuner W9NLT

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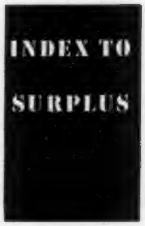

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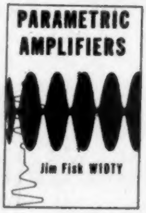

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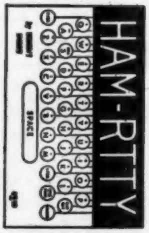

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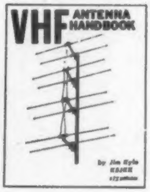

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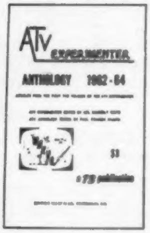

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So You Think You're on Frequency

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In at least one area of the United States a quiet war was recently waged by two separate and very active amateur groups. One of these groups is a two-meter RACES net operating on 146.84 MHz AM; the other is an FM channel in 146.82 MHz. The malcontent stemmed from the fact that individuals of both groups had frequently found themselves transmitting simultaneously on a single frequency. Not unnaturally, each person thought the other had drifted off his original frequency.

The AM net operator, just to be on the safe side, double-checks his crystal and verifies that he has the correct one inserted. He wants to lean over backward to be fair. He cursorily checks his transmitter stages to make sure all are properly functioning. Everything checks out. His crystal is plainly marked 146.84 (or some integral multiple thereof). He wonders why those FM operators don't realize their frequency errors. And the wonder eventually turns into a smouldering suspicion that perhaps the FM hams who purport to operate on 146.82 are deliberately interfering with the net. A strong accusation, but still . . .

The FM'er is crystal-controlled on 146.82 MHz. At least once each week he must suffer through the erratic squelching, garbled voices, and foreign carriers that stagger across his sacred channel as the AM hams check into their .84 net. He watches his bobbing, frenzied discriminator from time to time during check-in and cringes when he thinks of how much spectrum those stations consume, taken collectively. With disdain that nearly always turns to hot agitation, he notes that those net check-in stations may transmit anywhere between 146.81 and 146.87 MHz. But from experience, he knows that each check-in station—if challenged—will take an oath to being on 146.84. The FM'er has tried to explain the telling honesty of his discriminator meter to the AM stations in the past, but he's long since given it up as hopeless. The AM net operator is crystaled on—and everyone knows crystals don't lie!

So this is the biggest point of contention: To the net operator, 146.84 is whatever the signal is when the crystal is cut for .84 operation. To the FM station, 146.82 is wherever the signal is when the discriminator meter reads zero. The very honest fact is that the FM'er knows something the AM net check-in station probably doesn't: A crystal is NOT an absolute frequency-determining device.

The FM'er's crystal probably cost him around seven dollars; it was *specially ground for the circuit in which it is used.* The crystal manufacturer calculated circuit capacitance and other factors *based on this individual circuit information* to make sure the crystal would put the operator squarely on his "channel." Conversely, the AM station's crystal was probably cut without regard to the peculiar circuit parameters of his individual oscillator. As likely as not, his was originally a military crystal intended for use in an oscillator with a load capacitance of 32 pF. Or perhaps a commercial crystal intended for use in a 20 pF circuit.

Most amateurs aren't even aware of the differences. Most of us don't even know what type of oscillator our transmitters are using, let alone the load capacitance of the crystal circuit.

Whether or not the FM stations were at fault or the RACES net check-in stations were operating off frequency is really immaterial. What *is* important is the fact that a crystal *is not* an absolute frequency-determining device. This may come as something of a shock to bandedge operators who've been thinking they were safely operating all these years because they were crystal-controlled. There are a number of hams who say nasty things about crystal companies after they've been cited for off-frequency operation. But the crystal outfits aren't to blame. If there is blame to be placed, it must rest at least partially with the amateur himself.

The frequency stability and electrical behavior of a crystal may be considerably altered when the crystal is used in a circuit other than that for which it was intended. So what about all those FT-243's, you ask? What, indeed; they're no exception! It is the responsibility of the amateur to know his own frequency—and that means knowing something about the crystal he's using as well as the oscillator circuit.

Have you ever listened to an active net with a selective receiver? If so, you've probably wondered how so many close-tolerance crystals could be on so many different frequencies. Again, as likely as not, the fault may lie not so much with the crystal as with the circuit. Some oscillator circuits "pull" crystals to such an extent that the actual operating frequency may be as much as 20 kHz off the intended transmitting spot.

The crystal

In many ways a good crystal is like a poor hi-fi speaker. They are both transducers, for instance, that have the capability of converting electrical energy into mechanical energy (and vice versa). Both have resonant frequencies where they will react more freely to the induced energy. A poorly designed speaker will react violently to input signals near the resonant frequency, and will tend to "boom" as the signals approach this resonance. A well-designed crystal yields a reaction that is similar in many respects. As the induced ac voltage across the crystal approaches resonance, the quartz element becomes very stable and will tend to exhibit a high degree of activity.

For communications applications, there are two common types of crystals in general use. One is the plated type, the other is pressure-mounted. In general, the plated type is superior, but both have the ability to maintain a very high degree of accuracy on their established frequencies.

This is not to say that crystals can't be wrong, themselves. They can—and very often are! But a good crystal of the plated type, furnished by a quality-conscious manufacturer (such as Sentry or International) will very likely be *right*. Crystals that go wrong are usually the pressure-mounted types—the FT-243's that depend on stored energy from a mechanical spring to hold them in position. The surplus FT-243 crystals are very vulnerable to frequency change because of the possibility of positional shift between the crystal blank and the pressure electrodes, and because of gradual—perhaps even imperceptible—pressure changes.

But even if surplus pressure-mounted crystals were perfectly error-free, the problem of off-frequency nets would still exist.

Oscillator parameters

The two prime determinants of actual oscillating frequency are crystal current (drive level) and oscillator load capacitance. If you order a crystal when you're not sure of these factors, you will have no way of knowing how far off frequency you're going to be.

The most universally used value for oscillator load capacitance seems to be 32 pF; most first-rate crystal companies supply crystals to this value when the load capacitance is not specified by the buyer. But the 32 pF value is by no means restrictive; a large number of equipment manufacturers design oscillator circuits with widely varying capacitance requirements.

Most commercial and military two-way radios are designed with a variable capacitor in the crystal circuit so the crystal can be "bent" to frequency once it has been installed in the oscillator circuit. This seemingly important feature, for some unknown reason, is not usually included in amateur transmitters.

The table below shows the actual operating frequencies of a crystal cut for use in a 32 pF circuit of a parallel-resonant oscillator. The first column shows the actual design frequency (which is the end frequency when the crystal is used in the proper circuit). Note how the frequency drops as the load capacitance increases. The last column shows the resultant frequency of the crystal when used in a series-resonant circuit. (Although admittedly not particularly common, series-resonant circuits do appear in amateur transmitters from time to time. The old Black Widow line of VHF transceivers and Robert Dollar units used circuits of this type. At 50 MHz, the Black Widow operator was always about 10 kHz below the rest of the gang.

It should be noted that series-resonant circuits are not necessarily inferior to parallel-resonant types; the important point is that their requirements are different. In a series-resonant oscillator, the crystal is in series with a resistance. The crystal appears resistive, and load capacitance is no longer a determining factor with respect to frequency of operation. But unless the crystal is ordered specifically for a series circuit, the user will probably find himself considerably lower in frequency than he'll want to be.

In parallel resonance, the crystal is placed in series with a capacitance, so it appears as an inductive element to the external circuit. Any change in circuit reactance will affect the frequency of oscillation. This mode is of characteristically hig impedance and the resulting frequency is higher than that of the series-resonant crystal. The frequency of the crystal may be lowered by increasing the series capacitance or raised by decreasing it.

What can you do?

While I was preparing this article, I wrote to Sentry to obtain permission to use some of the information contained in the technical section of its 1968 catalog. In answering my letter, Mr. George Beyers, president of Sentry Manufacturing Company, said that his company is anxious to supply on-frequency crystals as most amateurs are to receive them. He said his company would be happy to correlate the frequency of a crystal circuit if enough information were made available in each case. So that provides you with at least *one* way to be certain of your frequency: if you want to operate on a specific frequency and you haven't ordered your crystal yet, you're in good shape. Determine the fundamental crystal frequency range, the desired operating frequency, then make a copy (even a sketch will do) of your oscillator schematic. Send the information to Sentry and wait for your crystal to be returned by mail. You can rest assured it will be exactly on frequency.

If you have no frequency-measuring equipment, but a known-to-be accurate signal is available, you can vary your existing crystal capacitance until you zero-beat the known signal. This is a particularly useful solution for a group of amateurs who participate in net activities. Netting several stations to a given frequency is a project that requires very little time, but one which is particularly rewarding for those who must monitor the net with narrow-bandwidth receivers. Adjacent-frequency stations will also be appreciative, you can be sure. These operators may position themselves far enough away from a net that the two concurrent operations could easily be accomplished. But the off-frequency check-ins always seem to find their mark; and the result is the same as it was in the case of the FM channel versus the RACES group: hard feelings and unnecessary animosity.

Varying the crystal capacitance to a frequency adjustment may be accomplished by replacing the load capacitor (between one side of the crystal and ground) with a trimmer. The original capacitor value should fall approximately in the center of the trimmer's range. In some oscillator circuits, the fixed capacitor that must be replaced is across the crystal itself. The proper capacitor won't be hard to find, in any case. A little experimentation should yield fruitful results.

Measured Crystal Frequency at kHz at:

32 pF Load	15 pF Load	40 pF Load	100 pF Load	Series Resonant
1000	1000.125	999.975	999.915	999.865
3000	3000.625	2999.880	2999.565	2999.315
5000	5001.325	4999.730	4999.020	4998.225
7000	7002.225	6999.525	6998.250	6997.250
9000	9002.835	8999.400	8997.800	8996.500
13500	13503.800	13499.270	13497.250	13495.750

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An objective observer viewing the cold war that brewed between the two closely spaced net activities on 146.82 and 186.84 MHz might smile with grim amusement. But to those participants, the problem was real and serious. Fortunately, the frequency-netting solution is simple and easy to effect. It's really a wonder someone hasn't thought of it before!

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Parallel-T Network Design

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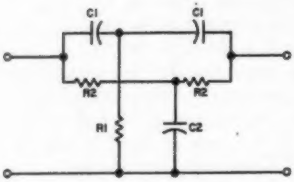


Fig. 1. The Parallel-T Network.

The Parallel-T network (**Fig. 1**) is a little-known RC circuit which produced infinite rejection of one specific frequency provided that resistance and capacitance values in it are properly chosen. This rejection property makes the network valuable for use as a lightweight low-current power-supply filter, for removing unwanted single-tone signals from amplifiers, and for use in feedback networks to produce oscillators and selective amplifiers.

Values of R1, R2, C1, and C2 are all inter-related, and will determine both the frequency of infinite rejection (f), and the sharpness of the rejection notch. Most published data on the Parallel-T treats only the case where R2 is twice the value of R1, and C2 is twice C1, but in actuality any set of relationships which will satisfy the following three equations at the same time will function as a Parallel-T:

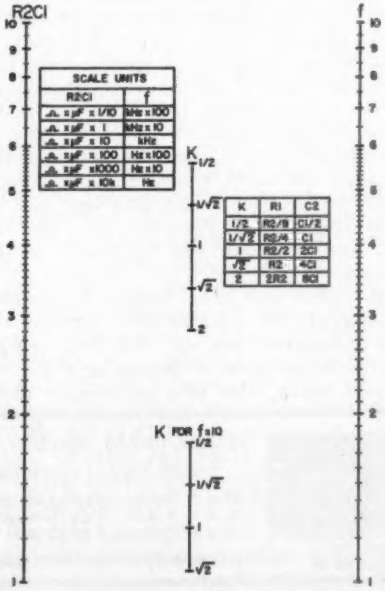
$1/wC1 = KR2$; $2R1 = K^2R2$; and $2/C2w = R2/K$.

(In these equations, K is a constant which determines the proportions of R1 to R2 and C1 to C2, and w is equal to $2\pi f$. If f is in cps, R1 must be in megohms if C is to be measured in microfarads).

The algebraically inclined can solve these equations to learn that the most-published version of the Parallel-T is that for a K of 1. However, if $K = \sqrt{2}$, or 1.414, so that R1 and R2 are equal, the slope of the sides of the rejection notch will be steeper. Versions published for use as audio notch filters consequently are usually based on a K of 1.414.

The accompanying nomogram can be used to solve the Parallel-T equations for any desired values of K and f, to an accuracy of better than 2 percent. The result is a product, R2C1, which in turn determines the values of all components. Either R2 or C1 may be chosen to be any desired value, and divided into the product to learn the value of the other. The table in the nomogram gives values of R1 in relation to R2, and C2 in relation to C1, for all listed values of K.

For instance, to determine proper component values for a Parallel-T to operate at 1000 Hz, with a K of 1.414, and a value of 10,000 ohms for R2, first draw a straight line on the nomogram to pass through 1000 Hz and K = V2. Either the 1 or the 10 on the f scale could be used, but the 1 mark (together with the "X 10" K scale) will give greater accuracy. This line passes through 1.10 on the R2C1 scale. To locate the decimal point properly, note that the frequency-scale units were "Hz X 100" (the added X10 multiplier was obtained by using the "X 10" K scale). Reference to the



SCALE UNITS	
R2C1	f
Ω x μF x 1/10	kHz x 100
Ω x μF x 1	kHz x 10
Ω x μF x 10	kHz
Ω x μF x 100	Hz x 100
Ω x μF x1000	Hz x 10
Ω x μF x 10k	Hz

K	R1	C2
1/2	R2/8	C1/2
1/√2	R2/4	C1
1	R2/2	2C1
√2	R2	4C1
2	2R2	8C1

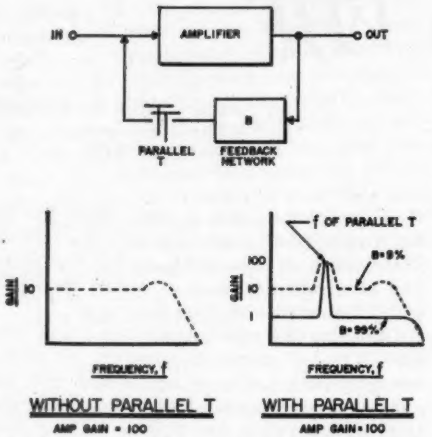


Fig. 2. A parallel-T in series with the feedback network of a degenerative amplifier.

chart shows that in this case, R2C1 is in *ohms x microfarads* x 100 so the true value is 110 *ohms x microfarads.*

Next, divide the R2 value of 10,000 ohms into the R2C1 product of 110 to determine the value of C1. In this case, it is 0.011 mfd for C1 (in practice, one 0.01-mfd and one 0.001-mfd unit would be connected in parallel to make up the total value). The table shows that with a K of $\sqrt{2}$, R1 equals R2 and would be 10,000 ohms also. C2 equals four times C1, or 0.044 mfd.

The actual choice of K and R1 is based on several considerations, which vary depending upon the purpose to which the completed network will be put.

For use as a power-supply filter with the rejecton notch placed on the predominant ripple frequency, the important considerations are to keep the total series resistance (twice the value of R2) at a minimum and at the same time to minimize the capacitance requirements. These considerations are contradictory. A K of 1.414 will minimize the value of R2, but a value of 1 for K will minimize the total capacitance requirements. In addition, for any specified frequency and K, choice of a low value for R2 will require high values of capacitance and vice versa. The resulting compromise must be made on the basis of the current to be drawn through the filter, and the space and weight limitations. Typical values used in practice for a ripple frequency of 120 Hz would be K = 1, R1 = 75 ohms, R2 = 150 ohms, C1 = 8.75 mfd (8 mfd actually used in practice), and C2 = 17.5 mfd (16 to 20 mfd actually used). Rejection exceeds 80 db at design frequency.

Placing a Parallel-T in series with the feedback network of a degenerative amplifier (**Fig. 2**) converts it into a frequency-selective amplifier, by reducing the negative feedback at the Parallel-T's frequency of infinite rejection. Thus the feedback can be arranged to maintain the amplifier's gain at 1 throughout most of the passband, and at the design frequency gain will rise to the no-feedback value.

Adding a minute amount of *positive* feedback to this selective amplifier will turn it into an oscillator. Positive feedback should be kept to a level which will just permit oscillation, while negative feedback (except at Parallel-T design frequency) should be such that gain without positive feedback is unity. The resulting oscillator produces the lowest distortion of its output of any known; the major reason it is not more widely used is that its frequency is determined by *three* component values while the popular Wein-bridge requires variation of only *two* elements.

In either the selective-amplifier or oscillator application, the major considerations are to maintain the impedance of the Parallel-T at a level compatible with that of the feedback network. At frequencies far below that of infinite rejection, the Parallel-T becomes effectively 2R2 in series with the load. At frequencies far above, it becomes essentially R1 in parallel with the load. Thus wide impedance variations with frequency are unavoidable.

However, choosing K equal to 2 will make 2R2 equal to R1, so that if R1 is then chosen to be equal to the load resistance the total impedance will vary from twice that of the load (at low frequencies) to half the load (at high frequencies). This is the minimum impedance variation with frequency which can be obtained from a Parallel-T.

The impedance variations, though, need not be considered a drawback in many applications. A resonant-circuit trap to produce the same effect has similar variations. And the Parallel-T does offer the advantage of much smaller space and weight requirements when dealing with extremely low frequencies, not to mention being less costly to construct in many cases. ■

Starting Off on VHF

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Avon Conn. 06001

With the advancements of current VHF equipment and the continued pursuit in moonbouncing, experimentation, FM'ing etc., VHF operation nowadays is becoming more and more intriguing and certainly offers many rewarding challenges absent in low band territory, where most green eared general's flock for so called "push the button" operation.

Great strides in VHF achievements have been made over the years on every VHF band that exist (when we refer to VHF, this includes 220 mc and 432 etc.). However there still remain vast segments in the VHF frequencies where there is virtually no activity. Some amateurs and organizations have prognosticated that the FCC won't be long or very reluctant in claiming back portions of the current VHF frequencies, generously allocated to us amateurs. This interpreted into another manner means that if we are to retain current VHF frequencies and the privileges that go along with them, we must all help spark more interest in VHF work and if possible, contemplate VHF setups for ourselves, preferrably on 2 or 6 meters and both if possible.

You've probably come across half a dozen or so advertisements highlighting the newest and most recent VHF equipment on the market. And while perhaps not as attractive as a nice low band kilowatt transceiver, you're probably much intrigued as to just what these VHF rigs can do. If you've never been on VHF before, I suggest you start off with a low cost transceiver for say $50.00 or so. Heath company currently offers the "lunch box series" of either a 2 meter transceiver (HW-30) or the 6 meter version (HW-29A). Both units are identical in physical appearance and structure and each sells for $44.95 apiece kit price complete with built in ac power supply and a ceramic microphone. Crystals and a dc power supply are optional. Assembling either unit is simplicity in itself and as a rule, can be completed in a few evenings of consistent work. Transmitter power input is 5 watts and the receiver is of regenerative type. The current ham publications occasionally offer modification plans for these two transceivers in case you'd like to improve upon its performance. I don't think I'm sticking my neck out in saying that these two little rigs are the most widely used low cost VHF transceivers around today.

Going up the price ladder you'll find several 2 and 6 meter transceivers manufactured by both Lafayette and Allied with an average power input of 20 watts. Receiver is of superhet type and built in VFO is also among the features. Other manufacturers include Clegg Laboratories, Gonset, Johnson in addition to several others. A brief letter requesting their catalog of VHF gear should do the trick and is your first step in becoming familiar with what's on the scene.

What about antennas? Among the numerous VHF antennas are yagis, ground planes, Halos dipoles, collinears, verticals in addition to others. VHF antennas in the majority of cases are much smaller than HF antennas, but the dozens of methods you can use in stacking beams, adding reflectors, experimenting with them, building and designing them, etc., makes VHF antennas a field by itself. Some VHF'ers stack up to five beams one on top of another resulting in a directive gain of over 50 db and sometimes more. Others like to homebrew and construct their own antennas sometimes putting up to 50 elements on one boom! Obviously, VHF antennas offer a unique opportunity to build your own skywires and simultaneously learn more about antenna construction and theory. The complexity to which VHF antennas may grow is startling. Some of the more advanced and sophisticated antennas used often for moonbouncing, microwave and several other uses are parabolic dishes, helical antennas, screen reflectors and corner reflectors. Some amateurs may stack half a dozen collinear antennas to form an array of enormous gain while others employ perhaps one screen reflector to equal that of the array of collinears. The amount of gain you want and the purpose for its need most often prescribes what kind of VHF antenna installation would be feasible.

Starting off with a commercially built halo antenna will give you adequate local coverage if you have a fairly good location and when hooked up to a low power 2 or 6 meter transceiver, will often provide reliable coverage and makes a dandy little outfit for ragchewing and net coverage. Extending your range using the same low power rig can be accomplished by installing a moderate 2 or 6 meter beam. Seven element 2 meter beams can be had for between $10-$25 depending upon the type and brand. 6 meter beams with three to four elements sell for $15-$30. Installing a yagi beam is no more difficult than installing a good size TV antenna. Attention should be given to the use of a balun however, an item often neglected by many VHF'ers. Use of a rotator is an absolute must if you do intend to use a beam antenna. The many disadvantages of using a beam without a rotator is obvious since the beam will transmit in only one direction and when in net operation with hams in all directions, you'd be lost. Same applies to roundtables with hams in different directions. 50 ohm coax is the feedline used in the vast majority of VHF rigs and its losses through somewhat higher than those of 300 ohm twinlead and open-wire line, are for the time being unimportant.

Range? Normal ground wave transmission on 2 and 6 meters with a power usage of 5-20 watts will as a rule exceed 20 miles and go as far as 45-50 using an omni-directional antenna of appreciable height. Using a beam will extend the range up to 60-70 miles and an occasional 100 mile contact isn't by any means rare. Making use of the ionosphere will of course stretch your signal for a long distance. Tropospheric bending is the most frequently encountered form of DX and 150-200 miles most often prevails in this case, though greater distances have been reached. F2 layer DX occurs at peak years of the 11 year sunspot cycle, and produce ranges nearing 2000 miles. F2 layer DX works well on 50 MHz operation only. Sporadic E layer DX is another frequent ionospheric occurence and normally will produce 400-700 miles or so on 50 MHz and up to 1400 miles on 144 MHz operation. Meteor scatter and moonbounce, among others, are all effective means of obtaining great distances with relatively low power equipment.

This article merely introduces the basic concept of what to expect on VHF, what's needed to begin and why more activity in this region is desperately needed. 220, 432, 1200 mc and higher have to be further explored and pioneered. For additional information on VHF operation, I strongly suggest you obtain a copy of the ARRL "VHF manual" available for $2.00 directly from League headquarters. If you have any further questions, I'd be glad to hear from you and would like to discuss the matter at length. You might also pen a letter off to 73 Technical Aid Group which is at your service for any assistance you might require. Good luck!

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Learning the Radio Code if You're over 30

Do you think aging is an obstacle to learning the radio code? If you are over 30 or 40 or so and you have been thinking of getting a ham ticket, learning the radio code probably looks like the hardest requirement. Actually, it seems to be the hardest requirement for people of *any* age. But if you feel your age imposes a specially tough barrier you are only partly correct. Very probably the difficulty looks much worse to you than it actually is.

The age problem

Any man at age 35 knows he could not win a footrace with himself at age 19. Yet he rarely wishes to trade off those years of experience, either, because he knows how much he has gained. And few 19-year-ods, however aggressive they may feel, will challenge a solid relaxed-appearing middle-aged man in a bar. The younger man perceives a certain stability and potential grim determination the older man can summon up if necessary, and he knows his youth might not be such an asset after all.

Yet our society places an almost frantic value upon youth and is so full of divisions between people the older person undertaking a new project almost certainly must feel at a disadvantage. There are stories of loss of learning ability and of mental capacity, and there are other disadvantages too, against taking up something new that is not related to previous experience or to the work at hand.

For instance, the older man very often has very little spare time. Business and family demands may keep him jumping to the time of a drummer he would rather not hear so much, but he cannot escape the beat. There is rarely an adequate place to study anywhere in the house, and code practice work is often very upsetting to others nearby who are not so interested in ham radio. And starting from scratch, while challenging, can also be a tough uphill operation in which hard work seems to generate disturbingly few results of any kind.

And it is perfectly well established there really is a decline with age of learning ability. This may be too obvious in very elderly people, whose memories tend to show a curious porosity for recent events but excellent recall for things that happened many years previously. Concentration span may be reduced, too, so that an older person cannot accumulate long hours of hard study at the same rate as a younger person. This all certainly sounds ominous, at the very least. Now, is it as bad as it sounds?

Something about learning

If we want to maintain a correct perspective on any problem we ought to do some book work. What are the facts? There is so much information available you can become swamped in it or entirely carried away. This effect appears in medical schools for example, where as new diseases are introduced and studied there is much concern among anxious students who feel they may have developed these illnesses. Tiny things are magnified by too much attention, but when you discover this effect your perspectives can be rearranged to a truer schedule.

The overall picture of aging effects upon learning ability is surprisingly cloudy. The changes are so small up to age 60 or so (on the average) that researchers are still having considerable difficulty in establishing solid results. Natural differences between people are very large compared to differences due to aging.

Test results indicate a fairly definite peak in learning ability somewhere in the third decade, ages 20–30 years, and a rolloff beyond that decade. But researchers are very careful to indicate they do not know what causes the rolloff, and they suspect a large part of the changes they think they observe are caused by psychological and social changes, rather than losses of inherent learning ability.

For example, studies of training older workers for new jobs have indicated the older worker may simply not be as strongly motivated as the young man. Society expects less of him, he expects less return from society, and has probably lost some, or maybe even all, of his youthful enthusiasm through hard knocks and frustrations. You can find this attitude in some conversation without looking very far at all.

Another cause of reduced effectiveness is the very real need for an older person to do better than a younger one. After all, he has been around longer, hasn't he? Should be able to do better. But the younger man has just completed 12 years of school, say, and perhaps four or five years of college. This is a far tougher experience if he worked at it. At age 17 you may have been viewed as a youngster by your parents and others, but you were also a battle-hardened veteran of many learning emergencies. You were accustomed to everyday hard questions, challenges, tests, book work, writing essays, dodging hard problems. You often succeed, and are not very upset by a prospect of failure. One, two, or three decades later you're so far out of shape for this stress you hardly recall what it's like much less what to do about it. You could panic now, and many older beginners really do.

Research indicates you can achieve practically as well as when you were at your peak, but you've lost the skill. This has been studied closely and one example is that of two professionals aged 35 and 72 years respectively. They did equally well in individual tests but when placed in competition under close observation the older man couldn't take it. He did far poorer work at learning than in previous unforced, non-competitive work.

The anxiety and work-against-pressure and competition effects appear to be the real obstacles in learning the radio code. Tense and worried, you notice the young fellow working like mad in the next seat. Feeling like a relic, candidate for fossil, you probably forget that young as he is he's a veteran, and old as you are you're a beginner. You've been psyched, you're sinking, and your general mood may be as low as panicky despair.

What should you do now?

Learning the code

Well, don't quit. Have a talk with yourself, rearrange your perspectives, and go back at it. You probably were not using the best approach anyway, although this is where your advantage lies. You do have a special strength! The younger man has slightly more learning ability, you have much more experience in life situations. He *can* persist longer than you can but probably you will persist longer than he *will*. He has fewer other things to do but you are more able and inclined to organize your time to best benefit for the job at hand. Now let's look at this code learning problem.

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There are three basic parts to learning. They are: Registration, Retention, and Recall. The code signal registers, and it registers best if you are not distracted by other problems or sounds. It sticks best if it registers well and there are not too many other recent things on your mind to compete with it. Finally, the meaning is recalled most easily if the previous two requirements are met, and if the recall process is well lubricated by recent practice.

After a decade or three out of school you tend to forget how slow the learning process really is. Over a period of time you have become accustomed to using familiar information and hardly ever finding new facts, to settle matters most usually worked out in minutes or hours at the most. Now, how long does it take to learn the code?

To reach 13 words per minute, 70 hours or more! At the recommended schedule of a half-hour study per day, that works out to 140 days and you'll need more time yet to attain a higher speed or if your practice schedule is not *daily*. In your second decade this gradual progress was a way of life. You forgot about that, didn't you?

Experience and study suggest the best way to get by with least expenditure of time. Firstly, find out what the books say about learning the code. If you just jump in you are passing up the results of other people's useful experience. A good description appears in the Radio Handbook. Unfortunately, the few paragraphs in the Radio Amateur's Handbook are worse than useless because they imply there is nothing more to it than appears there.

Then set up a study/practice schedule, same time and same place every day. Set yourself at it for a half hour, and for a couple of weeks or so do not ever exceed that time. Stick to your schedule. If later you feel you can profit by longer sessions, try it. But do not work into exhaustion.

If you can possibly find or borrow code tapes or records, use them. They are the very best practice, but many hams have learned the code off the air. You can do it too but it will take longer than a well-prepared schedule of exercises.

Next, stay with it. Do you know what a "plateau" is? This is a familiar experience to educators and to persons whose business is study and learning. A "plateau" is a period in which you are working like mad but there seem to be no results. One of the purposes of your study schedule is to keep you going from habit if nothing else while you are getting through a plateau experience.

Various persons have different difficulties in code learning, but there is one that probably is common to all. This is learning to "copy behind." In the first stages of learning the code, you are simply discovering which letters have which sounds. You will probably experience plateaus in this part of the work. But then you come to a stage at which you need to copy faster but the concentration on writing interferes with attention required to listen to the next letter.

As you continue working at this you are learning to put part of the work into the back of your mind where it goes on without attention. This is a skill that is hard to learn and probably every amateur you can find will give you another story about how he made it over the hump. At this stage in your progress you should think sometimes about how you drive a car, carry on a conversation while watching the other party. There are many things you already know how to do correctly without paying attention to the details. You have the ability but must train your mind in this new application of it.

I did not find anything while I was working up this article to indicate there are some people who are inherently unable to learn the code. Reading this work was a harder job for your mind than reading a code signal, although the code may be a less familiar way of communicating. If you're a beginner get onto the problem and you will learn the code with considerable effort as we all do, and if you have given it up in despair go back and try again. Plan ahead this time, and good luck!

. . . W2DXH

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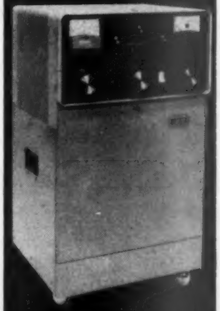

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Oscars . . . Emmies . . . and for the Amateur . . . The Sarah

The next annual SAROC (Sahara Amateur Radio Operators Convention) in Las Vegas will be the scene of the most elaborate and extensive amateur radio "awards" program ever attempted. Sentry Manufacturing Company has just announced the initiation of a continuing annual award presentation program for the ham radio world, to be conducted concurrently by the leading amateur journals.

In a ceremony resembling the Oscar and Emmy affairs of Hollywood, prominent amateur radio operators will be awarded "Sarah" trophies, each of which is inscribed with (1) the winner's name, (2) the category for which the award is presented, and (3) the name of the amateur journal which determined the winner. The name Sarah was chosen because of its similarity to Sahara, the Las Vegas hotel where the presentations will take place, and because it is a natural acronym for Sentry Amateur Radio Award of Honor.

73 will distribute awards for DX, VHF, public service, best technical article of the year, best nontechnical article of the year, and best published solid-state design of the year. 73 will also present one additional Sarah to the individual considered by the staff to be the Outstanding Amateur of the year.

All but the last mentioned category will be determined by 73 readers on the basis of mailed in nominations which will be accepted until 10 October. On this date, three individuals will be selected from the nominations for each category as finalists; their names will be published in the December issue of 73. The names .of these candidates will be forwarded in early December to the Sarah Committee, who will objectively evaluate the candidates and select the winner in each category. The Committee's decisions will be final.

Once the Sarah Committee has made its decisions, the winners' names will be forwarded to Mr. Ray Meyers (W6MLZ), a prominent west coast amateur, ham radio columinst for the Los Angeles Herald-Examiner, and radio commentator. Mr. Meyers, as emcee for the SAROC breakfast banquet, will make the actual award presentations.

No photo of the trophy is available yet, because the original design work is still under way. It will have the general character and size of a conventional Oscar award, however, consisting of a male figurine about 15 inches in height. The figure will bear a lightning bolt representing electromagnetic radiation and will be supported on a small pedestal of marble encircled by a metal band for the inscriptions.

Selecting Nominees

Nominations are now open for the six listed categories. Use as much paper as necessary and list the names of your candidates in any format you choose. For each category, try to list the name, call, and address of the individual you have named. (This is not mandatory, but it would be immensely helpful when it comes time to notify the winners.) In as few words as possible, tell your reasons for selecting your candidate. You are entitled to only one nomination per category per journal, so be sure to sign your name and list your own call letters. Here are the particulars on the six 73 Magazine categories:

Best Technical Article of the Year.—Look through the pages of back issues of 73 to September of last year, and pick out the one technical article that seems outstanding to you for some reason. Perhaps it was a useful circuit that you used; maybe it was an informative piece that did a good job of filling in fuzzy spots in your theoretical understanding of a subject. What-

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ever your reason, write it down. Tell the name of the article, the author, and give your reason for naming it the best technical article of the year.

Best Nontechnical Article of the Year.—73 often carries outstanding nontechnical articles of interest to radio amateurs. As you look through those back copies, select a particularly important nontechnical article that you believe warrants perpetuation in the annals of ham radio. This entry might be any article from the pages of 73 that you found particularly helpful for some reason. All you have to do is give the name of the article and the author, and cite the reason why you feel the article is outstanding.

Best Published Solid-State Design of the Year.—This should be no problem at all. 73's pages are rich with solid-state projects and articles from its knowledgeable readers. Which of these did *you* build? Maybe a published integrated-circuit article helped you in a miniaturization project. Or maybe there's a design you've been saving to try later. List the deisgn you think is best and give your own reasons. Remember, you are the one who determines where these coveted awards will go.

73 Public Service Award—Here's an area where back copies probably won't help. Do you know an amateur whom you feel has contributed something "extra" to his community on behalf of amateur radio. Maybe you know of someone who went out of his way to do a service for a fellow human, such as using his radio station to pass traffic in an emergency. Or perhaps you know of someone who has performed some service for the benefit of the public that is undramatic in nature but worthy of commendation. He'll never be commended unless the anateur radio world knows of his actions. Give his name, call, address, and state his praiseworthy act.

VHF Award.—What individual do you feel most deserves a citation of merit for performance in the field of VHF? A two-meter moon-bouncer? A six-meter DX'er? A 432 experimenter? It's up to you. Give his name and call, and state why you feel he is particularly worthy of being awarded the VHF Sarah.

DX.—What amateur radio operator do you feel has contributed most during the year to the field of amateur DXing? There are quite a few to choose from. Who went out of his way to give fellow amateurs a chance to work rare countries? How about a DXer who stayed selflessly for hours at the mike so that more amateurs could add a particular country to their lists? What do *you* think? Some amateur will be awarded a Sarah for DX, and it's your job to determine that individual.

The most important thing to remember is to get your nominations in before October 10. As a matter of fact, why not do it now—before you forget? Use any kind of paper. Write it longhand or typewrite it—it makes no difference. All nominations are welcomed. At the top of your sheets, place your name, call, and address. Then list the categories, your nominations, and your reasons as indicated above. Then mail your entry to:

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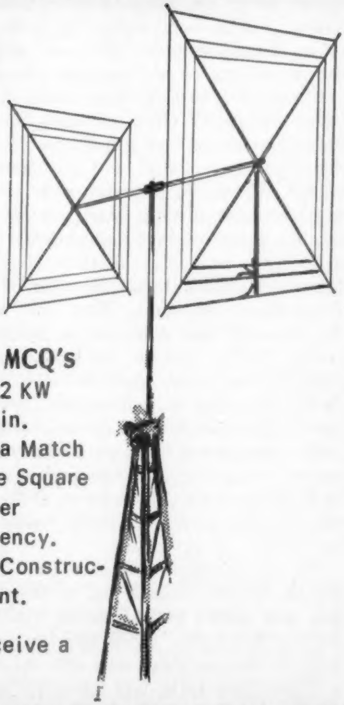

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1296 Megacycles-1968

Bill Ashby K2TKN
Box 97, Sunet Lake
Pluchemin, New Jersey

Without doubt, this UHF band of Amateur frequencies has the most promise and with a few outstanding exceptions, provided the least results. Consider the tremendous efforts put forth by Sam Harris and his whole group at W1BU, Hans and the group at HB9RG, the Eimac club on the West Coast, and Tommy, KH6UK, in order to get the first Moon-bounce contacts on 1296. These must be considered as successful experiments that provided all of us with some valuable numbers but lead nowhere at that time, for these groups found it necessary to use equipment unobtainable to even the very serious UHF Amateur. Like mountain-climbing, after getting up there and back, you are not really sure it was worth the effort and certainly not worth repeating—what do you do for an encore! The other side of the coin is the poor soul who reads a glowing report in an old issue of one of the magazines, talks his buddy into this deal, scrounges up a couple of APX-6's, and they spend the next few weeks getting these bombs working, just to find they could have done better with a TWOER and a clip-lead antenna.' This can be described as an old experiment, often repeated and not leading anywhere. All in all, a pretty poor piece of *rf* spectrum considering the problems of Antenna, impossible feedline losses, *rf* output and drive headaches, and a 15 db noise-figure with a handbook converter. How many times have you heard, "Boy, 1296 would be the band if you could work Moon-bounce, using 2C39s and a back-yard antenna." *Friend, that is precisely what G3LTF and WB6IOM used to get signals from California to England in June.* If this seems impossible considering the problems mentioned, you are forgetting the availability to all Amateurs of Varactors, Transistors, 3 db couplers, and the experience of those hardy pioneers on 1296.

"3 db Coupler—Whats that?" That is a simple flashing-copper box or piece of strip-line that allows you to use *one* 2C39 amplifier to drive *two* 2C39 amplifiers to drive *four* 2C39 amplifiers, etc. etc.

This same little box provides right-hand circular polarization transmitting and left-hand receiving without switching.

As the memory expert once said "I don't have anything that every four-year old doesn't, but I have spent 30 years developing it" aptly describes the work of the two Peters, G3LTF and WB6IOM. Although each is an extremely competent, state-of-the-art electronics engineer, they have chosen to expend their energies in the direction that many of us more-or-less fortunate Amateurs understand and can participate in.

The best example possible to describe the type of development work Amateurs do best can be summed up in the unit amplifiers being used. Starting with the 2C39 triplers described years ago by W1WID, add the cavity development by WB6IMO (QST Jan 68), Vapor-phase cooling by W2CLL, and a year of hard work on final design of Cliff, W2CCY, and any Amateur anywhere in the world can build a 1296 transmitter of any reasonable power deemed necessary. Of course, the availability of Ceramic 2C39's and 3 db couplers helps, but would be useless with out the efforts of the above Amateurs.

Keep in mind that these signals on 1296 are the weakest signals ever used for communications of any kind, so nothing can be skimped in the receiver. Amateurs have been building par-amps successfully for ten years now and the ready availability of low-noise (5 db) transistor for second stages and mixers (QST Nov. 67) has eased the receiver problem. See info by Al K2UHY on *rf* amplifiers. Replace the collector circuit shown with a two-meter tuned circuit and link. Reduce the bias for 100 microamps of collector current, then inject enough 1152 MHz via a link near the base circuit to drive the collector current back up to one mA. and you have a low-noise 1296 mixer. We have finally seen the last of crystal sets, even on 1296!

Antennas, feed-line and tracking problems are still just as big a problem as ever, but Peter WB6IOM has shown us all that if you get the transmitter and receiver straightened out, a 10 ft dish on a simple back yard mount with a coffee can feed will cut the buck—it doesn't make it easy, just possible. After finding his echoes with the par-amp, Peter can still hear them with the 5 db second stage, so he sure has the antenna situation well in hand.

During the past year, steady progress has been made here on the east coast by Cliff W2CCY who has managed to interest quite a group into getting on 1296 for nightly local contacts. He has shown that 18 db of antenna and 50 watts of clean signal will do a real job out to 70 or 80 miles without openings of any kind. Transistor front ends have made a significant improvement in this type of work in the past year.

1296—1968 It should be recorded somewhere that this was the year that Dick W2IMU and the group at W2NFA not only generated a successful series of 1296 tests out of Crawford Hill that resulted in contacts with Europe and California, but of far more long term import, lead to the back-yard to back-yard signals of WB6IOM to G3LTF with much more to follow.

. . . K2TKN

VHF Awards

As many of the VHF hams are interested in getting some sort of wall paper to show off to their visitors, I will try to get a few listed just in case you might want to paper the wall and not pay a lot either. Many of the numerous certificates I have were absolutely free of any cost other than the stamp and the envelope. Of course, I think my proudest one is the DXDC #404 from 73 with the 6 meter endorsement. I have the letter from Wayne telling that it was the first for 6. I know many others are qualified but there again, some do not go in for even QSL's.

I have been quite active on the air with both this call and also my 2nd station K8BDT but never had so much fun till I went to SSB over a year ago. I helped form the Florida VHF Sidebanders, of which I am president. Any one working 10 full members of the gang; send the info to me and receive a very nice certificate free and postpaid.

The Golden Triangle Coffee Club has 2 nice ones; one for working the 5 charter members and the other for checking into their morning get together on 50.5 between 6 and 7 AM. Send 3–6 cent stamps to WA4VVW along with the info from log. You also must send QSL's to members worked.

The Floridora Y L's have a very nice one for working 10 of the gals, any mode or band, the info with 35¢ to K4RNS. Endorsements for each extra 10 gals are available from Marg.

The Florida Chapter of the National Awards Hunters Club has a real nice award (along with 4 gold seals) for working 150 of members of NAHC. Many of them count as 2 due to being charter members of their chapter, so get out the old shoe box and start looking for them. Then send list, and 3–6¢ stamps to Al Man—WB4CQU.

The Bayou City VHF club of Houston, Texas also has a real nice one for working 7 member stations and sending the log data to WA5DUJ. A few stamps would be appreciated.

The 6-meter club of Dallas (Texas) has a nice one on parchment for working member stations. Send to Louise—K5ZAM with SASE for correct number to qualify.

The Greater Pittsburgh VHF Society has a nice gold one for issue. Send SASE to W3BWU for more details, other than the fact it's for free.

WBCQU is also custodian for the Michigan Screwballs. Send a few stamps along with the "Screwballs" worked and even get a pin & your certificate.

The Wheat Straw Radio Club in Calumet, Oklahoma has a nice one for working 6 member stations and sending a stamp or so to K5GBN.

Another nice one and free to the XYL, can be had for sending a note to Mabel ℅ W4IYT (editor of Fla. Skip) telling how much she does putting up with you as far as ham radio is concerned.

. . . K4LLF

CLUB SECRETARIES NOTE

Club members would do well to get their club secretaries to drop a line to 73 and ask for the special club subscription scheme that we have evolved. This plan not only saves each club member money, it also brings badly needed loot into the club treasury, if desired. Write: Club Finagle, 73 Magazine, Peter Boro Ugh, New Ham Shire 03458.

The VK3ATN Moonbounce Rhombic

Wayne Green W2NSD/1

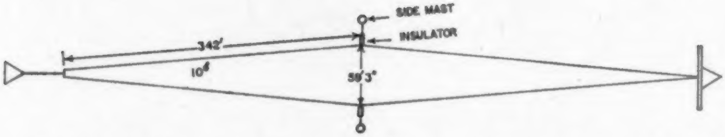

Fig. 1. The Moonbounce Rhombic doesn't require very high towers, the top of it being only 35' in the air. The ends of the antenna are tied to the two end towers and the slack in the wires is taken up by counter weights on pulleys on the side masts. A track on the tower in the forward direction permits the whole rhombic to be swung a few degrees one side or the other to permit aiming it at the moon and thus giving you four or fire days a month for bouncing instead of the one or two you would get if it were fixed. The side pulleys permit easy moving of the positions of the side wires to keep the antenna in shape. Ray tried apex angles between 8° and 12° and found that 10° seemed to be optimum.

In January 1966, after being convinced by W1FZJ/KP4 that a long, long rhombic would have the gain necessary for moonbounce on two meters, even with the 150 watt power limit of Australia, Ray Naughton, VK3ATN started researching the published data on these antennas. It was sparse indeed. He worte to some "authorities" to find out what he might be able to expect from, say, a 50 wavelength long rhombic.

It soon became apparent that he would have to just go ahead and build one and find out for himself what actual in-practice gain he would get, what lobes would develop, and even more important, what the actual direction of radiation would be. This was, understandably, critical since he intended to point the gigantic antenna at a spot in the sky where the moon would pass on about two days a month. Even a few degrees error and no moon.

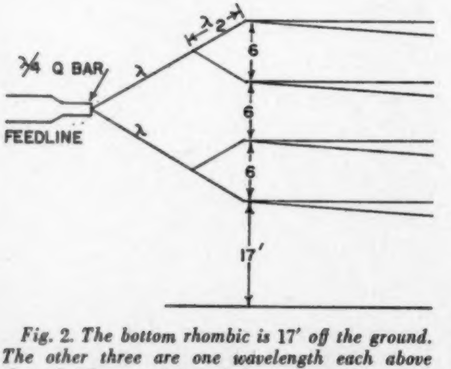

Fig. 2. The bottom rhombic is 17' off the ground. The other three are one wavelength each above that, 6'. They are fed by half wave sections which are in turn connected by two full sections of feedline. The match is made with a quarter wave Q-bar. The half wave, full wave and feedlines are all made with #12 AWG hard drawn copper wire spaced ½".

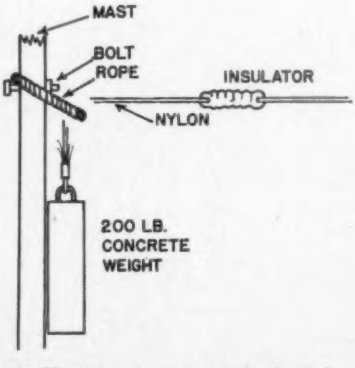

Fig. 3. The 200# concrete weights hold the wires of the rhombics so that there is only about 2' sag in the 342' stretches of wire. You'll need four of the weights for each side, one for each rhombic. Arrange to have them hang down close enough to the ground so you can reach them without a ladder as you have to adjust them now and then, particularly when you want to swing the antenna a few degrees one way or the other.

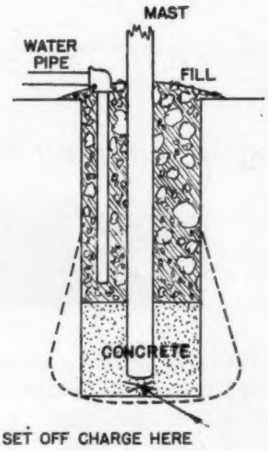

Fig. 4. Ray has towers and masts all over the place and has some good words for planting these things. If you want to plant a tower or mast so it will stay planted through anything dig your hole down as diagrammed. Put a couple of pieces on the bottom of the tower to keep it from pulling up vertically. Put a small dynamite charge in the bottom of the hole. Fill up the hole a little less than half way with concrete. Then put a water pipe down into the hole, almost down to the concrete layer. The end of the pipe should be perforated. Fill the hole with dirt and stones to a mound above the top. Set off the charge. This will expand the bottom of the hole and fill it with the wet concrete. Then run water into the pipe until it runs out the top. Pull out the pipe and when it all dries out you will have a tower or mast that will confound your great-great grandchildren.

Rhombic theory was fairly well established, but Ray wanted to stack them and little had been done on this. Collins had used stacked rhombics during some of their tests during the 50's on 49 MHz, but their published data was of little help.

During February 1966 Ray erected a 50 wavelengths long two-stacked rhombic. He missed the February moon pass, but was all set for the March pass and, sure enough, back came his echoes. They were weak so he got to work and added two more rhombics to the stack. The result was definitely readable and at times strong. By June he was getting good readable signals through from K6MYC on scheds, but Mike was having troubles in receiving and not yet able to hear his own echoes, much less Ray's.

The first two way for Ray turned out to be with K2MWA. The boys in New Jersey got a chance to use the big dish there during the December 1966 moon pass and K6MYC, who had just installed a receiving filter and was finally set to work Ray, had to sit there, biting his fingernails, hearing both K2MWA and VK3ATN, but missing out on the first U.S./Australia two meter moonbounce contact. This was in November 1966. In December it was Mike's turn and he made it through to Ray.

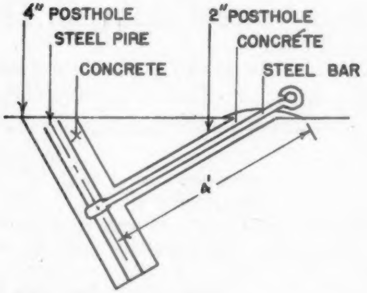

Fig. 5. Most of us just screw our guywire deadmen into the ground and let it go at that. Not Ray. He makes a permanent job of it per the diagram. Use a 4" posthole digger and cut into the earth at about a 45° angle away from the guy wire direction. This hole should be about 6' deep. Then with a 2" posthole digger run a hole in from 45° in the other direction so it comes out in the 4" hole. Put your 4' long guy shackle into the 2" hole. The ring on one end should just stick above the ground and be verticle with the ground. The other end of the shackle has a ring at 90° from the top one and a steel pipe should be passed through this ring and driven into the ground until it is below the ground level on top. Do not use galvanized pipe as this will rust. Fill in both holes with concrete. Let the concrete come up around the loop on the end of the shackle to half cover it for maximum strength. This is a little more work, but it is not likely to come up in a wind.

The bounce club had regular get togethers on 15 meters to coordinate their work and schedules. They decided on a code for bounce contacts to save time. "1" meant they were hearing occasional signals, but that they were not identifiable. "2" indicated identifiable letters. "3" meant complete call sign and report received during two minute call period. "4" indicated almost 100% copy. "5" 100%. After using this system for a while they found that the dots of the numbers tended to get lost in the fading. Next they

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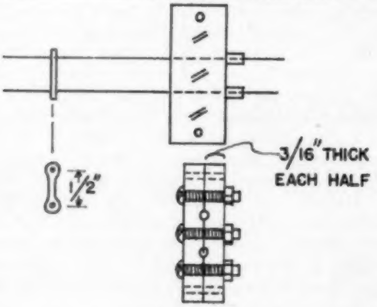


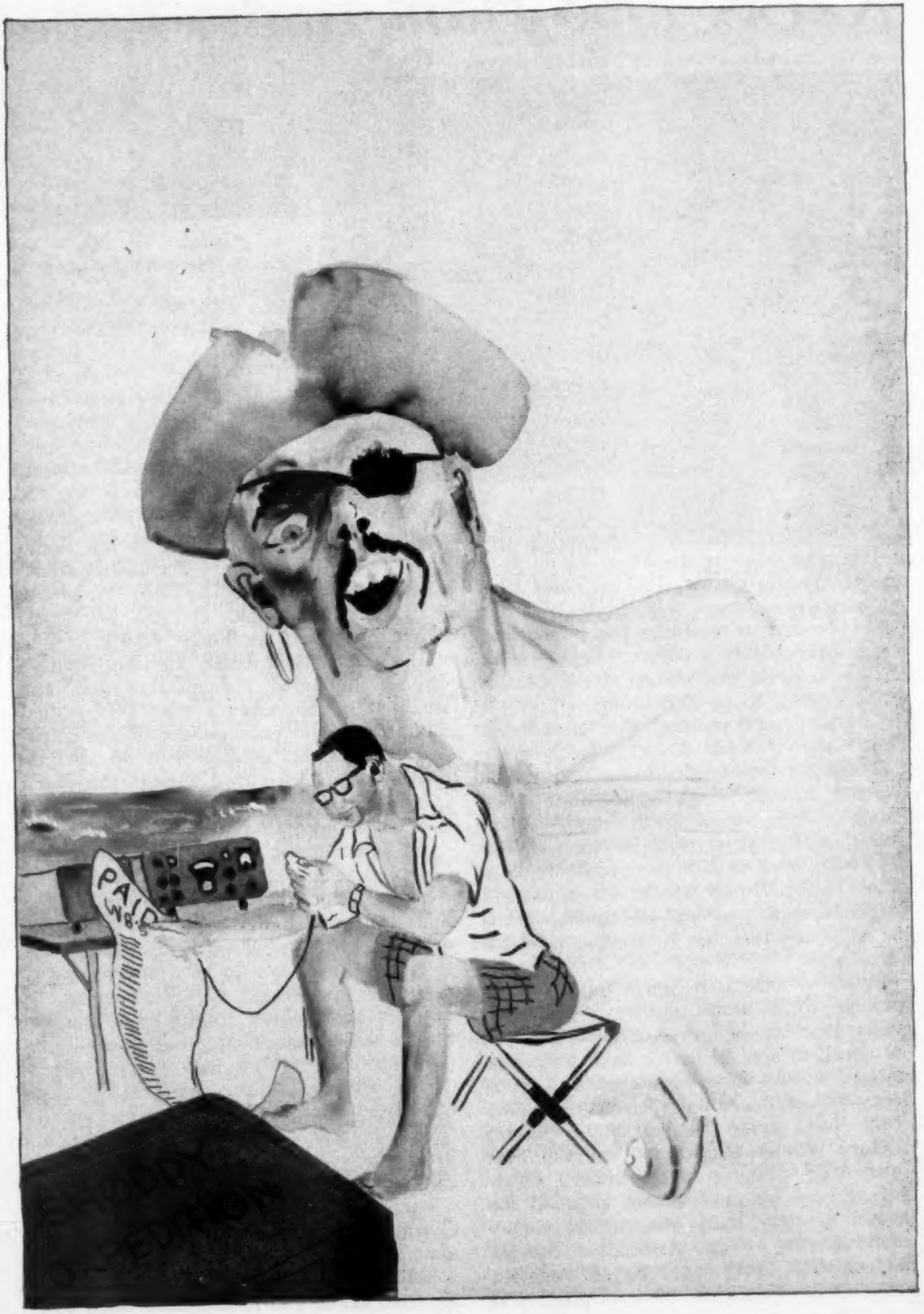
Fig. 6. Ray uses these little half inch spacers for his feedline. They are spaced out every 8' along the line to keep any discontinuity to a minimum. On curves he puts them above every 6". He keeps about 200 pounds tension on his feedlines to keep them in shape, taking up the strain with blocks per the diagram. These polystyrene blocks are used to hold the half and full wave sections, the Q-bar and the feedline taut. The loss of the system is kept very low this way. The half inch spacers are a commercially made item, the blocks are home made.

tried sending "T"s for 1, "A"s for 2, "E"s for 3, "I"s for 4, etc. Still not so good . . . losing those dots. The present system is to use a series of "T"s for 1, "M"s for 2, "O"s for 3, "MT"s for 4, and plain SSB for 5.

The frequency used is around 144.09 MHz. The stability must be good, staying within a few cycles. You have enough problems on moonbounce without having to tune around the band chasing signals.

Ray experimented with various aperture angles for the ends of the rhombic. He tried from 8° to 12° and settled on 10° as being the optimum. It is rough making empirical tests like this for those two days a month go by rapidly and take a long time to come again. On April 24th he got back about 8 minutes of echoes. Nothing on the 25th, the 26th, 27th or 28th, then 12 minutes of echoes on the 29th! More changes and then in May nothing on the 20th, 21st, 22nd, 23rd, and 24th. At last, on the 25th some echoes! And nothing more for the month. It is slow frustrating work this way.

Would tilting the rhombic elevate the lobe? No way to know until you try it and see what happens. The answer, to save you a few months of finding out for yourself, is no. . . . W2NSD/1



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EDITION

K2US: 1968 Ham Radio Expo

Mel Snyder WB2DLW/K3AFW
Box 15
River Edge, N.J.

In an era when citizens band and commercial gear have supposedly stolen much of amateur radio's glamor, 15 ham clubs from northern New Jersey believed that all the hobby needed to recapture the public awe was a little overdue exposure. They got their chance to prove this theory at the Garden State Amateur Radio Exposition.

Like most great ventures, this "Ham Radio Expo" started with a lucky break–Steve Flehinger, assistant advertising and public relations manager of the Garden State Plaza, Paramus, N.J., saw a story about Vietnam phone patches in a local newspaper. The story suggested to him the possibility of a major public display at the Plaza, world's biggest shopping center. He contacted first the FCC and then the Newington gang for advice.

Several months later, north Jersey's hardworking SCM Louis Amoroso, W2LQP, finally got wind of Steve's inquiry, and put out a call to area clubs for an organization meeting. Twelve clubs, associations and emergency groups, including such angust names as the North Jersey DX Association, Quarter Century Wireless Association and the East Coast VHF Society, sent members. Other clubs present or soon to join included the Bergen Amateur Radio Association; Englewood Amateur Radio Association; Knight Raiders VHF Club; Land Rovers Amateur Radio Club; NASTAR; New England FM Repeater Association; North Jersey Radio Club; Stevens Institute of Technology Radio Club; Tri-County Radio Club; Watchung Hills H.S. Radio Club; Oakland 550 Club; Army, Navy and Air Force MARS.

Harry Dannals, ARRL Hudson Division director, attended the meeting and was stunned by the response; the League had withheld official endorsement of the Expo, fearing it might "conflict with the division convention in Tarrytown later in the year." Dannals noted that no division convention ever began so enthusiastically.

As committees formed and the work began, the club representatives made clear the reason for this enthusiasm–the Garden State Amateur Radio Expo was to be no ordinary hamfest, where hams merely talk to hams. "Expo" was to be a unique opportunity to open lines of communication to area non-ham publics, ranging from prospective amateurs to influential community leaders who often decide anti-tower ordinances and what to do about serious TVI cases. Given the chance to change some of the "bad ham" image, north Jersey amateurs attacked the opportunity like a smoking Field Day rig.

For Steve Flehinger and his supervisor, George Chirogene, the planning was awesome.

"This hobby dissolved into a tangle of ominous words and phrases like "high volt-

Two Red Cross volunteers help young visitors fill out message forms at traffic setup at Expo.

age," "250-foot coax feedlines" and "just how many amps is this place wired for?" Steve recalls.

"This place" was an empty store in the giant Plaza—7000 square feet of highly prized space, with big plate-glass windows on three sides. And the Expo dates couldn't be more attractive—May 2 through May 4, anniversary sale days at the Plaza, when perhaps 75,000 of the area's bargain-happy shoppers would flock to the center.

Despite possible incidence of Murphy's Law, Expo rolled along from its January beginning. Qantas obligingly flew in Ray Naughton, VK3ATN, of "Moonbounce" fame. Ray captured the interest of hams attending the VHF Conference, which also starred Ralph Thomas, KH6UK; Hans Lauber, HB9RB, who contacted Raf's friends at Crawford Hill Amateur Radio Club via 1296 mc moonbounce less than a month earlier; Ray Conkel, W6DNG, and many others. The public was charmed by Ray's great Aussie accent and his fine color slides of "down under."

With a few days to go, the FCC approved K2US for use at the Expo. And NASA sent a "Surveyor" satellite display, and prepared for two theater shows on outer space for Saturday crowds.

Three well-known DX'ers: Ed Hopper, W2GT; "Musty" Mustermann, W2TP; and Vic "the Digger" WA2DIG discuss the ragged shape this recent pack of DX QSLs arrived in (note: all were salvaged and forwarded!)

Bergen Amateur Radio Association presented "Gateway to Amateur Radio," an exhibit showing how to obtain an amateur license. The thousands of Expo visitors watched BARA member Paul Irvine, WA2ANI, and his dad, John, K2GXX, assemble a Heathkit receiver at the booth. Hundreds of youngsters received "Certificates of Communication" marking their first contact via amateur radio, over a 2-meter station in the display. Another section of the BARA display handled visitor questions about TVI, and how it can be cured. A key part of this section was an operating portable TV set with only a rabbit-ear antenna, operating only a few feet from the SR-2000 station loaned by Hallicrafters for K2US contacts—the screen never once betrayed a hint of interference. Hallicrafters donated 12 of its amateur license course kits for a drawing at the BARA display, and hundreds of youngsters flocked in hopes of winning the combos of code record, ARRL manuals and CPO.

A moving moment at Expo: blind non-amateur at left is shown how to tune receiver by unidentified Mount Carmel Guild ham who is also blind.

East Coast VHF Society members demonstrated the latest in VHF gear and communications techniques. An amateur TV two-way station set up by Alan Katz, K2UYH, drew large crowds, as did a 16-foot-long OSCAR tracking station exhibit set up by NASTAR's Nick Marshall, W6OLO/2. Nick, who was technical director of OSCARs I and II, used big display boards to show visitors the contents and functions of all OSCARs to date, and exhibited a model of OSCAR I in the booth. Nick also displayed plans for Project Moonray, and demonstrated a sub-laser communications system over which visitors could speak. The modulated laser beam was de-

CW aficionados Steve Petrucelli, WB2WPX, and Al Bianci, WA2BCN, dazzle Expo visitors with dits and dahs at the outdoor information booth.

tected and used to modulate a 432 MHz transmitter, similar to the way Project Moonray may operate.

Land Rovers Amateur Radio Club showed the public the wide range of RTTY activities possible, from traffic handling to general QSO and "picture" transmission. Prepared tapes on Expo fed a network of teletype printers around the exhibit hall, telling visitors about Expo activities and amateur radio. The New England FM Repeater Association, organizers of an FM Conference held in conjunction with Expo, presented an impressive display on the equipment and communications networks possible with this mode.

Englewood Amateur Radio Association and Tri-County Radio Club combined to present "This is Field Day," an exhibition of a tent-based station and panels of photos and newspaper clippings of past FD activities. An exhibit showing the performance and preparedness of the Amateur Radio Emergency Corps was sponsored by the Knight Raiders VHF Club.

Contrary to his Aussie comrades' jest, VK3ATN is not the longeared type at center! He's at right, displaying the friendly little kangaroo the Garden State Plaza brought to welcome Ray to Expo. Dick Turrin, of the Crawford Hill (NJ) Radio Club group that first QSO'd Ray via 144 moonbounce, joins in the fun.

Traffic-handling at Expo was directed by Doug Rue, WA2ASM, Tri-County Radio Club, and Knight Raiders president Jack Wilk, K2KDQ, net control of the Passaic Valley Traffic & Emergency Net. Their club members manned VHF and low-band rigs operating AM, SSB and RTTY in routing traffic to the National Traffic System and MARS on 75, 6 and 2 meters. Outside the Expo hall, in their mobile trailer crammed with gear that left public and hams a little awed, personnel from First Army MARS alternated between handling Vietnam traffic to Hawaii and showing visitors the equipment.

North Jersey DX Association was prominent with a display prepared by Herman ("Musty") Mustermann, W2TP. The display showed the wide range of awards and trophies for which amateurs compete using QSL cards, as well as the methods the association uses to handle their QSL bureau responsibilities for the second call area—22,000 cards per month, on the average!

In a typical moment at K2US, BARA vice president Marv Tischler, WB2TEA, takes a break from contacting to explain station to visitors.

Proof of the hobby's unique rewards for the handicapped were displayed by Alex Alexi, WA2AJE, and other hams from the Mount Carmel Guild, Newark. In a display assembled by Stevens Institute Amateur Radio Club, Alex and others showed blind and sighted non-ham visitors how one tunes a rig when deprived of vision.

Ed Raser, W2ZI, proprietor of one of the nation's top antique radio museums, displayed and demonstrated amateur transmitting and receiving equipment from the early days of the hobby. Ed, who splits his time between SCM duties for southern New Jersey and representing the Delaware Valley Chapter of QCWA, highlighted the display with a crashing half-KW rotary spark trans-

K2US-TV, set up by Alan Katz, K2UYH, gives visitors a look at a homebrew ATV station.

mitter, and a commercial 10 KW hand key as big as a billy-club.

Watchung Hills High School Radio Club prepared a display on radio astronomy for the Expo. The Watchung Hills students showed equipment and antennas they have built for studying signals from deep space and solar and moon-reflected noise. Photo displays illustrated how amateur radio operators began this field in the mid-30's. The students also ran a rear-projection movie on the history of radio that drew 15-40 viewers at every continuous showing during the three-day exhibition.

The recently-formed Oakland 550 Club showed equipment built for hidden transmitter hunting—transceivers, portable loops, etc. An impressive scrapbook of photos and newspaper clippings confirmed the club's expertise with their gear.

Out on the mall area of the Plaza, WB2DLW and other BARA members manned a 40 CW station that attracted hundreds of shoppers to the Expo information booth, and then into the main exhibit hall. Posters explained the reasons for CW, code requirements for various license classes, and the QRP International Amateur Radio Club rules under which the station operated.

First Army MARS operators show visitors inside of van packed with military equipment. MARS maintained link to Hawaii throughout Expo to handle Vietnam-bound traffic.

And there were many others— 73, *Ham Radio*, International Mission Radio Association, and even a small ARRL booth that contributed to the overall view of amateur radio seen by the crowds. Local newspapers carried Expo news on Monday, Tuesday, Wednesday and Friday of the action-packed week, helping to swell the crowds.

To those who called K2US and were not answered, we offer only the apology of heavy local QRN and our primary responsibility of telling the public about ham radio; to those who were answered, we ask that you QSL via the Bergen Amateur Radio Association, Box 15, River Edge, N.J.; BARA will route cards to those stations you QSO'd at Expo.

Jim Joyce, WB2MEE, holds ticket-stub box for IMRA's Brother Carman in drawing for Hallicrafters code sets at BARA booth.

Now that the Expo has ended, planning for the next Expo seems imminent. The event did a great deal for the image of amateur radio in north Jersey, and should be a model for others elsewhere.

. . . WB2DLW/K3AFW

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6 Meter Exciter

Kenneth W. Robbins W1KNI
Sperry Rand Research Center
Sudbury, Mass. 01776

During 1965 "73" magazine published a series of articles by Bill Hoisington K1CLL describing heterodyne transmitters for 6 meters.[1] They are fine rigs, the writer having verified performance by breadboard models. Cold start frequency drift averaged about 1 kHz and this only during a short warm-up period, thereafter holding steady within 100 Hz or so. During the summer of 1966 a modified version of his Slippery Six[2] was constructed using a 3A5-1R5-1L4 tube line-up with solid state regulated power supply. After a few minutes, frequency drift would level off to about 50 Hz per hour even with line voltage excursions of 20 volts. Spurious output signals were 36 db below a 75 mw carrier which drove a 5763/829B transmitter.

Like some vacuum tube receivers, oscillator power may be left on to eliminate warm-up drift. In early 1967 an "always-on" experimental VFO was built using two 2N706 bipolar transistors in an oscillator/buffer configuration on 14MHz. Ambient temperature variations were smoothed by a ¾ inch soft pine enclosure lined with aluminum foil.

After stabilizing for 24 hours it was operated as a carrier-reinsertion signal on 20 meter SSB stations with receiver in its AM mode. No drift or instabilities were detected. Assuming the SSB station is drift-free, this test requires 50 Hz or less frequency change to keep a voice sounding natural. For home stations use, continuously powering frequency generating circuits is OK but is not too practical for portable or mobile use.

Experience with bipolar transistors has shown they are not easy to "tame" for VFO use[3] but most certainly the new FET's are a natural. One of the first to appear was W2YM's unit with eye-bugging performance figures.[4] Recently W1DTY described his version using JFET's.[5] These new unipolar devices when used in a modified Solid State Slippery Six[6] enable the construction of a hybrid 1 watt output 6 meter exciter having excellent frequency stability, small warm-up drift, low spurious output and 12 volt dc operation (dc/dc converter for tube b+). How this may be done and resolving of various problems that arose is recounted in the following paragraphs.

Little difficulty with the VHF crystal oscillator was expected so its design came first. As is well known, power dissipation in these crystals *must* be kept small to minimize drift due to heating and accelerated aging. For CR23/U and similar units, maximum power specification is 2 mw. How to stay within this limit without some kind of automatic leveling feed-back? Since class C oscillators are amplitude-limiting why not reduce B+ to a low value and thus power in the entire circuit. Many transistor spec sheet curves show good gains with a volt or less and Ft extending into UHF frequencies. A silicon transistor made for TV luner local oscillator use is the GE 2N3662 having an Ft of 1.2 gHz and priced at 75 cents. It appeared to be a likely candidate so breadboarding commenced with B+ supplied by a single flashlight cell. Of various circuits tried, we liked K1CLL's the best since it does not require "tuning out" crystal capacity and impedance levels around the quartz loop are low and easily optimized. Overtone crystals between 45/46 MHz were tried and CB transmit crystals running on their fifth overtone worked just as well; this rig uses a channel 23-T unit marked. 27.255 whose 5th O.T. is about 45.425 MHz.

Low B+ seems to be one easily applied technique in getting crystal power down because warm-up time averaged 5 minutes with a drift of 15 Hz then holding steady within 10 Hz, when checked on a frequency counter. Temperature has a large effect on frequency; warming the metal can with finger heat will produce a few hundred Hz change. It was decided to power the VFO continuously during operation, switching the crystal oscillator off during receive.

Using a resistor as a coupling element, buffer base drive was adjusted for best mixer performance with minimum 45 MHz signal. Other things being equal, frequency insensitive resistance coupling reduces pulling as compared to reactive devices.

VFO circuitry evolved into a configuration using W2YM's oscillator with a source fol-

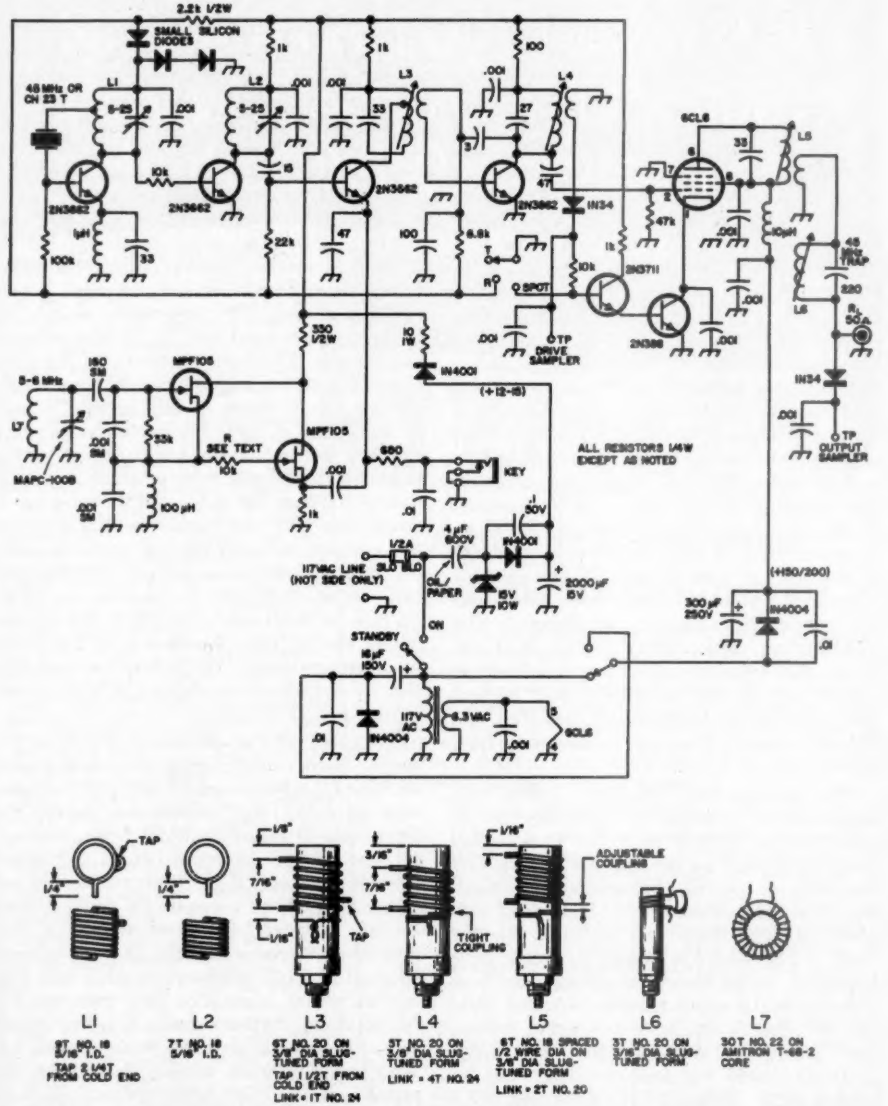

2.2k 1/2W
SMALL SILICON DIODES
48 MHz OR CH 23 T
L1
5-25
.001
L2
5-25
15
1k
1k
.001
.001
33
L3
100
.001
27
L4
2N3662
10k
2N3662
2N3662
1µH
100k
33
22k
47
100
6.8k
3
47
2N3662
IN34
6CL6
33
L5
7
8
6
2
47k
.001
10µH
1k
10k
2N3711
T
R
SPOT
.001
TP DRIVE SAMPLER
2N388
.001
48 MHz TRAP
220
L6
RL 50Ω
IN34
.001
TP OUTPUT SAMPLER
330 1/2W
10 1W
IN4001
(+12-15)
MPF105
5-6 MHz
150 SM
L7
.001 SM
33k
MAPC-100B
R SEE TEXT 10k
MPF105
680
.001
KEY
.001 SM
100µH
1k
.01
ALL RESISTORS 1/4W EXCEPT AS NOTED
.1 50V
4µF 600V
IN4001
1/2A
117VAC LINE (HOT SIDE ONLY)
SLO BLO
OIL/PAPER
15V 10W
2000µF 15V
ON
STANDBY
(+150/200)
300µF 250V
IN4004
.01
16µF 150V
.01
IN4004
117V AC
6.3VAC
.001
5
6CL6
4
TAP
1/4"
1/8"
3/16"
7/16"
1/16"
TAP
7/16"
TIGHT COUPLING
1/16"
ADJUSTABLE COUPLING
L1
9T NO. 18
5/16" I.D.
TAP 2 1/4T FROM COLD END
L2
7T NO. 18
5/16" I.D.
L3
6T NO. 20 ON 3/8" DIA SLUG-TUNED FORM
TAP 1 1/2T FROM COLD END
LINK = 1T NO. 24
L4
5T NO. 20 ON 3/8" DIA SLUG-TUNED FORM
LINK = 4T NO. 24
L5
8T NO. 18 SPACED 1/2 WIRE DIA ON 3/8" DIA SLUG-TUNED FORM
LINK = 2T NO. 20
L6
3T NO. 20 ON 3/16" DIA SLUG-TUNED FORM
L7
30T NO. 22 ON AMITRON T-68-2 CORE

Fig. 1. Schematic and coil data.

lower like W1DTY. A 3N128 MOSFET circuit had a slight edge in smaller drift but an order of magnitude greater sensitivity to changes of B+ versus frequency (note double ft regulation in the original article). Caution *must* be observed during handling and an *rf* diode is required for class C bias. N channel JFET's tried were Siliconx E103 and Motorola MPF 103 thru 105, the latter being finally chosen. Good load isolation is provided by a FET buffer whose gate series resistor value is varied to optimize mixer emitter drive. A zener regulated B+ voltage is mostly to limit power input (and lessened warm-up drift) as the frequency versus voltage change is small. During testing, without a zener, B+ was varied from 9 to 15 volts while the exciter supplied a carrier-reinsertion signal on a SSB station at 50.107, receiver mode being AM. There was no discernable change in voice pitch! A more critical test can be made by beating the fundamental VFO carrier around 5 MHz against a thoroughly stabilized 100 kHz marker in the receiver and adjusting for a low beat of about 1 Hz as indicated by the S meter. This resolution of a few parts in 10^7 shows up effects of B+, loading, temperature, etc. in a hurry.

Mixer performance was poor until collector tapping on its tank enabled a compromise between high Q, impedance matching and sufficient power gain. There was concern about VFO harmonics being amplified to a level where spurious emission would be unacceptable and in initial circuits tried this proved to be only too true. Also, a worse case condition occurs when a VFO harmonic coincides with a desired mixed frequency. A power ratio of only 13 db was obtained in one test; .5 watt carrier, 25 mw of 11th harmonic. Excessive mixer drive level was one reason but wave-form distortion in the VFO/buffer section was really at fault. Worse case spurious outputs in this finalized version are 50 db below a 1 watt carrier. This includes 45 MHz crystal feed-thru, the link trap having been set as described later on.

The straight-thru transistor buffer was impossible to stabilize by neutralization as first constructed and for some time a 330 ohm partial load on the sampler pick-up link was used to prevent self-oscillation. Shielding of low level stages to obtain final amplifier stability refocused attention on the "hot" buffer, where its instability might have been due to insufficient shielding also. Sure enough, bridge neutralization worked right off and energy lost in a swamping resistor now provides a well saturated grid drive.

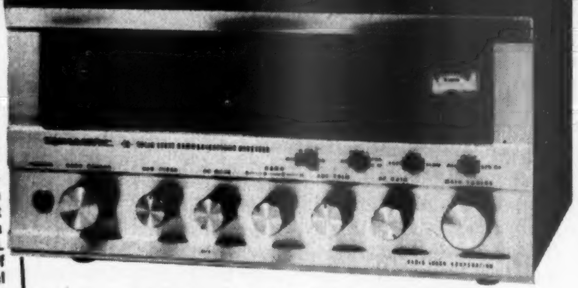
Tubes tested for final amplifier use included 6EJ7, S686, 12BY7, 5763 and 6CL6 with the latter winning first place. Although its plate area is similar to a 5763, internal shielding is much better and gain at 50 MHz is good. Early tests indicated neutralization was in order because of persistant self-oscillation. However, after considerable electronic detective work, it was found that plate tank energy was radiating back into the sensitive low-level 45 MHz circuits, thus setting up a feedback loop required for oscillation. A simple metal shield completely enclosing these stages licked that problem for good and tuning thru plate tank resonance yields not the slightest trace of grid current variation. I suspect operation is in its self-neutralized frequency range which is a welcome bonus. No low frequency or VHF parasitics are in evidence either.

A Darlington transistor gate in series with the cathode performs like a screen grid clamper. 1 volt or more of dc applied to the 10 K resistor causes output transistor saturation and tube current is normal. When *rf* drive is zero (key up, mode switch on receive, spot, crystal out, etc.), sampler output is also zero and there is no forward bias. Transistor impedance becomes high causing tube current to fall, around 5 mils or less. This circuit also has an odd effect on tube current when mixer/driver tuning is varied. Plate mils start to climb with detuning until at 60 mils, sampler voltage is down to a volt and further detuning causes the current to drop rapidly towards zero. No *rf* drive and a dc cathode ground will cause tube dissipation to soar to 14 watts; 70 mils at 200 volts. Therefore this simple circuit should help to extend tube life under no-drive conditions. Perhaps it has possibilities as a cathode modulator if the exciter is run as a QRP rig.

For those who would like to duplicate this exciter, some construction hints are passed on. For L2, close wind 10 turns of insulated wire on a 5/16 form, remove and secure the turns with Duco or Ambroid cement. When set, unwind the ragged end turns and adjust according to coil data. Add a little cement where it tends to peel off. To tap L1, bare ⅛ inch of wire and bend it like a tiny inch worm. Sweat solder the loop closed then proceed like L2, winding in such a way that crystal socket connection and coil tap will be adjacent, with 2¼ turns between it and B+. For other coils, close wind tinned bus wire on a 11/32 form, adding extra turns. Remove from the form, stretch, then fully compress. It will spring open naturally after which it is slipped onto a ⅜ form by a slight unwinding process like a wrap-spring one way clutch. Self-tensioning will hold it in place while trimming to size and cementing. A few extra turns on the toroid will permit frequency adjustment later.

Locate the 2N3662 mixer buffer so that its collector lead can connect directly onto L4, insulated base lead projecting thru a

No, we're not lazy! It's just that "Popular Electronics" (Dec. 1967) tells the DX-150 story so well.



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"What may be the first really noteworthy
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wave product detector for SSB/CW reception
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$119.95, the DX-150 has the flexibility of a
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is used to buying for $175-plus. To rattle off
a few more "features": there is a front panel
antenna trimmer, fast or slow a.v.c. attack,
a cleverly concealed built-in monitor speaker,
plenty of calibrated bandspread, and noise
limiting in both the i.f. and audio stages. Be-
cause of the solid state circuitry, the usual
warm-up drift expected with a tube-type re-
ceiver is virtually absent here. And, although
the DX-150 is primarily a base station re-
ceiver with a 117-volt a.c. power connection,
it can be operated from an outboard d.c.
power supply consisting of only 8 D-cells.
Radio Shack claims that the receiver will op-
erate for 100 hours — continuously — using
only the d.c. supply. Ideal for Field Day and
emergency work! The proof of the pudding so
far as any communications receiver is con-
cerned is how well it works "on the air".
At POPULAR ELECTRONICS, the DX-150 was
hooked up to a 125-foot long-wire antenna
and tuned across the AM broadcast band.
Needless to say, the S-meter was pinned on
just about every single channel, and the
audio quality with Radio Shack's voice-selec-
tive speaker (extra, $7.95) was crystal-clear.
Tuning the band between 1.55 and 4.5 MHz,
your reviewer got a chance to appreciate the
comfortable handling on SSB reception. Going
a little higher (4.5-13.0 MHz), the 25- and
31-meter bands were "alive" and signals ap-
peared to leap out of the air — possibly
due to the very quiet background of the
DX-150. While quietness is usually regarded
as a lack of sensitivity, that wasn't the case
with the DX-150. On the top band (13-30
MHz), the sensitivity still seemed high; and
on the CB frequencies, the DX-150 could hold
its own against a dual-conversion receiver
built just for CB work. **Summary:** Radio Shack
has the Model DX-150 in most of its 160 re-
tail outlets. Take a look at it, and get the
"feel" of this unusual receiver."

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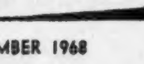
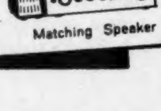


12 VDC Power Set



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small hole for wiring to L3 drive link and emitter lead trimmed to 1/32 inch and grounded. Another small hole is required for the neutralization connection. Resistor leads running to +12 volts pass thru drilled holes whose ground foil side is chamferred back for insulating clearance. VFO and tube socket sub-assemblies are pre-wired before attachment to the main board.

Copper-clad printed circuit stock is just great for small rig construction; it provides wiring, insulated tie points, chassis, shielding and easy solder-ability all rolled into one! Finalized circuit board is number 4 of a series to be tried in the development of this exciter. Most leads are short and direct. Coil terminals are positioned for minimum lead length to concentrate inductance about the tuning slug. Double clad boards make it easy to apply B+ and ground for distribution of power about the "chassis." Insulated connections are made by cutting narrow channels thru the copper with a Moto-tool and small burr. Ceramic trimmer capacitors and crystal socket are epoxy-bonded in place.

One gallon anti-freeze or oil cans are a convenient source of metal for shielding. Paint remover such as TM-4 quickly removes labeling, leaving a bright tin-plated surface that solders readily. This was used for all metal work required in the exciter. A heat conducting tube shield is highly recommended. Tube socket chassis temperature is fairly high but it is just about ambient near the crystal and VFO area using either horizontal or vertical mounting (tube uppermost).

Initial tune-up and check out should adhere to the following schedule. Connect a jumper wire between pin 1 of the tube socket and ground. For ease of removal during test and trouble shooting, just tack solder the low level circuit shield to ground at each corner. Install a 6CL6 and its shield but do not energize. "Kill" the VFO by shorting its tuning capacitor plates with a bare wire and do not install a crystal. Connect a low current voltmeter such as a Simpson 260 to the drive sampler test point. Apply +12/15 volts at about 40 mils to "Lo B+" and vary all tuning adjustments in a random manner in an attempt to start parasitic oscillations. Zero meter reading indicates all is well and this must prevail before proceeding. A change of neutralizing capacitor value might be required; its value is fairly non-critical however.

Install a crystal and tune the crystal oscillator, buffer, mixer and mixer buffer to its frequency around 45 MHz as indicated by a reading of 2 to 3 volts dc. Operate the mode switch and optimize oscillator tuning for positive starting with best output. Now, enable the VFO. Notice little or no change of meter reading. Mixer and mixer buffer slugs are then backed out a few turns, peaking up on a similar meter reading with output now at 50 MHz. VFO low limit and frequency range may now be set by appropriate adjustment of toroid inductance and the series padding capacitor. This particular rig tunes 50.15 to 51.4 MHz.

50 db of signal/spurious ratio demands nearly ideal mixer operation but it is easily checked. With tuning adjusted as described, zero VFO output should result in a reading of about .1 volt which is crystal feed-thru. With crystal out and VFO running, try peaking up on an in-band harmonic using the station receiver and its S meter. There will be some transistor "white" noise along with a small signal (about S7) but no dc volts on the meter. Variation of the FET buffer gate resistor gave results as shown.

R	DC Meter	S Meter
4.7k	70 mv	+40
6.8k	20 mv	+20
8.2k	trace	S9
10k	none	S7
VFO plus crystal		(crystal out)
8.2k	3.2v	S9
10k	2.8v	S7
18k	1.7v	S6
33k	1.0v	S3
open	.4v	S3

Just a few minutes is required to run a test like this and it enables a best choice of resistor R, in this case 10K. Only if transistors are changed need it be repeated, being a set-and-forget adjustment.

With the solid state circuits squared away, final amplifier tune-up is next. Connect a 50 ohm dummy load to the output BNC. Disable the VFO and retune all slugs to crystal frequency. Move meter, 10 volt scale, to the output sampler and energize the tube. Peak all tanks, about 8/10 volts indicated then carefully resonate the trap for best null, around a volt or so. Do not alter its tuning unless a different crystal is used. It provides a 22 db reduction in spurious feed-

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thru. Back out tuning slugs a few turns, enable the VFO and tune up on 50 MHz for a meter reading of about 10 volts (B+ at 160 volts.) Verify the signal as being in-band with a wavemeter, receiver, etc.

Leave all power on and stop the VFO. There should be zero volts at the final sampler, again .1 volt of drive sampler output. Crystal removal drops this to zero also. Check for parasitic oscillations by random tuning of all slugs; sampler outputs must remain at zero, tube current steady at 70 mils. With VFO running, once again try to peak up on an in-band harmonic. Results should be similar to the previous test, no sampler outputs, noise and signal somewhat higher due to tube amplification. Its a bit rough on the "bottle" but generates lots of confidence in exciter stability and insures a clean signal.

Finally, retune for proper operation on 6, remove the cathode ground wire and check out gate performance. For tripling to 2 meters, output at 48 MHz may be obtained by using a 43 MHz rock, remembering to retune the trap. Always keep in mind that *correct* tuning means: "No VFO output –no final output." Tube output will stay high if the VFO is stopped and incorrect tune-up was made on crystal frequency. Pulling the crystal is *not* a valid test; output will be zero in either case.

The exciter with +160 volts on the plate will drive an 829B to 12 grid mils thru a 5.6K grid bias resistor. The previous battery tube version with its fancy regulated power supply for filaments and plates driving a 5763 buffer produced 8 mils. At maximum tube dissipation, +200 volts will yield a 1 watt output.

From a cold start, drift is about 300 Hz in 15 minutes settling down to something like 35 Hz per hour thereafter. This would seem to be acceptable performance for portable or mobile use. For home station use, warm-up drift may be eliminated entirely by continuously powering the transistor section; a novel power supply is suggested. It will maintain B+ witahin a .2 volt for line voltage excursions of 85 to 135 volts, is short-circuit proof and draws less power than an electric clock in the standby mode. The VFO may be enclosed in rigid foam plastic for ambient temperature smoothing as the coil and capacitor have non-zero temperature coefficients. Its output may then

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be applied to the mixer emitter thru a length of shielded wire.

It is hoped that this little heterodyne VFO rig will appeal to many of the 6 meter gang. Since its absolute stability is good, operation on hf bands via a power mixer could be used to heterodyne *down*. For 10 meters, 50.5 MHz beating with 21.5 MHz to get 29.0 MHz, as an example. Low budget hams can shop around for bargains from Meshna, Poly-Paks, etc. and build it for about 20 dollars. Surplus scroungers with fat junk boxes could cut that figure in half. Its quite possible other high frequency transistors would perform as well or better than 2N3662's. A couple of 2N918's tried worked fine. Rag chewers will appreciate its stable operation, running for hours on end without distress. Frequency hoppers can adjust the tuning for flat output over a few hundred kHz or full spread with slight touch-ups of slugs, mostly the sharply tuned mixer. Inveterate tinkerers will note a polarity reversal protection diode, current limiting resistors to prevent sudden death of a transistor should a test prod slip and an oddball regulated power supply which keeps its cool when shorted, trying only to improve 117 volt line power factor. And if you're "hooked" on frequency stability like me the exciter comes close to state of the art for LC oscillators!

The "do-it-yourself" adjustment and tune-up technique was cross checked on a spectrum analyzer in the lab. Using a 1 watt carrier for O db, crystal feed thru measured −51 db worse case VFO harmonic −53 db and circuit noise −60 db. A couple of CB crystals could be made to "twin", a double mode oscillation heard as an audio tone on the carrier; a slight retuning of the crystal tank stopped it.

In conclusion, a tipe of the ole fedora to K1CLL, W1DTY, W2YM and others whose previously published accounts got this project off to a flying start and to Mrs. Bob Trefry for yeoman effort with her typewriter.

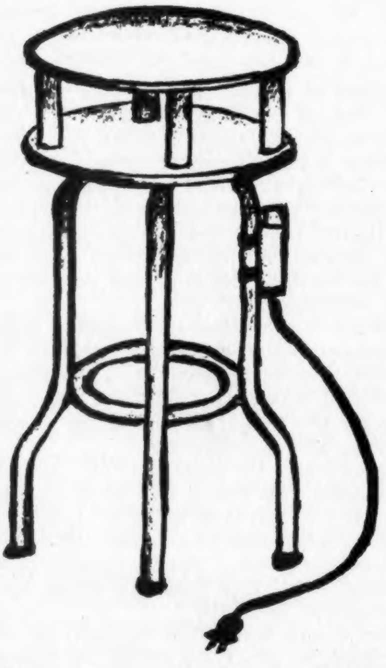
. . . W1KNI

References:

1 6 Meter Heterodyne VFO Transmitter 73 April 1965
2 Slippery Six 73 Nov. 1965
3 VFO Stability, Part II 73 Jan. 1966
4 The MOSFET as a Stable VFO Element QST Jan. 1967
5 AN FET VFO for 80 Meters 73 May 1967
6 The Solid State Slippery Six 73 Dec. 1965

Appliance Operators— Please Turn Page

Lee Lansing Jr. WA4WAI
P.O. Box 236
Triangle, Va. 22172



How many times have you wanted to monitor for a band opening on VHF; waited your turn on the net or just wanted to rag-chew and at the same time be able to catch up on a favorite home brew project?

Normally the average shack does not have bench space at the operating location to permit such a situation.

This project provides for a simple, inexpensive bench, which is portable, and provides for rotation of the bench top to simplify turning of a chassis as well as providing for parts and tool space close at hand.

If you are an avid home-brew fan, read on.

Keep a weather-eye out for a bar or counter stool of the chrome tubing type with swivel top. These normally have a ball bearing base to the seat which is approximately six to eight inches in diameter and permits 360° rotation of the seat. Remove the wood screws which secure the seat to the bearing plate and your project is well on the way to completion.

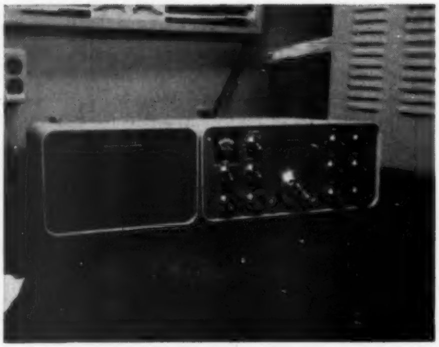
Cut two eighteen inch diameter pieces of one-half inch plywood (or other size as desired) and finish with paint, varnish or shellac. Cut four pieces of one-and-one-quarter inch closet pole (soft pine) or square stock, six to eight inches in length and finish in same manner as plywood. Secure the closet pole pieces to the plywood with wood screws about one-half inch from the outer edge at the quarter points in such a manner as to provide two round shelves spaced six or eight inches apart. Place the completed shelf assembly on the floor and invert the stool on the shelf assembly; locate on the center lines and secure the stool to the shelves with appropriate wood screws. The completed "bench" can be provided with an electric outlet, mounted on one leg, for soldering gun or iron, with "patch-cord" to the nearest convenient outlet. A small vise can be mounted on the lower shelf to assist in holding these small parts "too hot to handle" when soldering. The lower shelf affords storage for tools and parts while the top shelf becomes a rotatable bench for the chassis, rig or what have you. Procure a three quarter inch pad of foam rubber or plastic to use as protection when working on panels or components which may be scratched by a hard surface.

Note: This project is not compatible with a reclining type lounge chair.

Mexican Licenses

Mexico seems to have relaxed a bit on amateur radio licenses and you may be able to get one if you are planning a trip down that way. The open door border has been strained by an influx of hippies and weirdos from our country and now it is necessary to get a Tourist Card from a Mexican Consulate before crossing the border.

A Review of the Heathkit SB-110A



Matthew T. Lewis DS2
U.S.S. Biddle (DLG34)
FPO New York,
New York 09501

Want a really great transceiver for six meter SSB? Then this is the one! Assembly takes about thirty to thirty-five hours, and the most difficult step is stringing the dial cord for the final loading. This took me about fifteen minutes of trial and error, mostly error.

A look at the instruction manual will show that all printed circuit boards (six in all) are assembled first. All parts for these are packed in a separate box, so one box is all that should be opened at the start. Assembly of the PC boards, which appear to be of high quality, takes about five or six hours for all of them, including counting and sorting parts prior to starting.

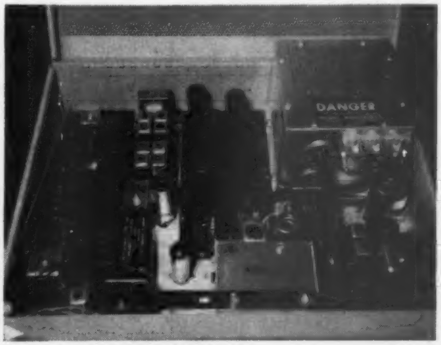
All instructions are very specific, and easy to follow. The boards are also marked on the component side with parts values, so it is very difficult to make any errors, except by carelessness. When all boards are completed (one resistor is left off the receiver RF board for later installation) they are set aside for later use.

Next comes the installation of parts onto the chassis. For this, the chassis is divided into twelve sections, six on the top and six more on the bottom. After a good portion of the parts are installed, including the PC boards, the final stage wiring is begun. Next comes the wiring harness, which is made by Heath, thankfully. A few wires must be trimmed to provide hook-up wire for later use, but all others are precut to the correct length and stripped. After the wiring harness is in, and partially wired, the coax harness is installed (also precut and stripped). Wires are soldered to the foil side of the PC boards, and the remaining parts are installed. All of this is very easy, due to the excellent drawings and detailed insets in the book.

When construction is complete, before alignment, you will have two resistors left over. *Don't worry about it.* The 47 ohm half watt is used for alignment only, and the 33k two watt is installed in the receiver *rf* stage, after neutralization.

Next comes the alignment. The only test equipment required is an eleven megohm VTVM (or solid state voltmeter, I used the IM-17), a fifty ohm dummy load (light bulbs are no good), and a receiver capable of receiving WWV or a broadcast station on a multiple of 100 kHz.

Some nice features of the SB-110A are its ability to use crystal control for transmit or transceive, with front panel selection, the crystal socket is inside and it takes a crystal in the 4.975-5.525 MHz; the built in



A Peek Inside The SB-110A

100 kHZ calibrator; two antenna connectors on the rear apron, one for the transmitter and one for the receiver, or use the internal relay; phone patch input; ALC input; a spare phono jack for whatever you want (*rf* out for a monitor scope, etc.); and a spare hole which will take a phone jack, this is used for a brass bushing when used with the mobile mount. There is also a set of relay contacts which close on transmit, brought out to the power plug. A CW sidetone generator is included which provides about an 800 Hz. tone and has its own level control (internal). In the CW mode, the receiver is in the USB mode, and the transmitter uses an offset crystal for carrier generation, which bypasses the balanced modulator, so when you tune a CW signal for an 800 Hz. note, you will be close to zero beat with him. The SB-110A also has an excellent noise limiter which is turned on by pulling out the audio gain control. The AGC is normally fast, but pulling out the *rf* gain control adds .2 mfd, which slows it down considerably.

Unfortunately, Heath included no provision for AM operation. However, if AM is really desired, the carrier null adjust pot inside could be adjusted for about 50-75 watts carrier input, and the microphone level cut down to prevent "overmodulation". This will give you carrier and one sideband, but there is no way to turn off the receiver BFO.

The crystal control feature is quite nice, as it allows split frequency operation for DX chasing, or crystal controlled tranceive for net operation. There is an internal trimmer to "rubber" the crystal slightly and get exactly on the desired frequency. It appears that minor rewiring is all that would be required to use the SB-640 external LMO which was designed for use with the SB-101, but Heath has no comment in their ads. However, page 99 of the instruction book shows an external VFO connected to the spare phono jack.

When the SB-110A is completed, all that is needed to get on the air is a power supply, a speaker or phones, an antenna, and a key or microphone (Amphenol 80MC2M connector furnished with kit). The recommended power supplies are the HP-13 for mobile (12 VDC) and the HP-23 (117 VAC) which fits quite nicely into the back of the matching SB-600 speaker.

As far as performance goes, the SB-110A far exceedes the Heath spec sheet. I measured 10 db S+N/N at .05 microvolts using an AN/URM-26G and a Simpson 260, and the CW output is slightly over 100 watts measured with a Bird thru-line wattmeter into a fifty ohm load.

In summing up, although I found the SB-110A easy to build, I don't recommend it for anyone who has never built a kit before. Start off with something a little easier, like a Twoer or the power supply you plan to use. Or try the IM-17 solid state multimeter if you don't have a VTVM; for twenty bucks, you can't go wrong. All in all an outstanding rig for the serious six meter SSB man, who wants an easy to operate, well performing rig with a very pleasing appearance, and a reasonable price tag. See you on six.

. . . WA2ZSA

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Six Meter Transceiver

D. P. Bryan W2AJW
4 Crescent Drive
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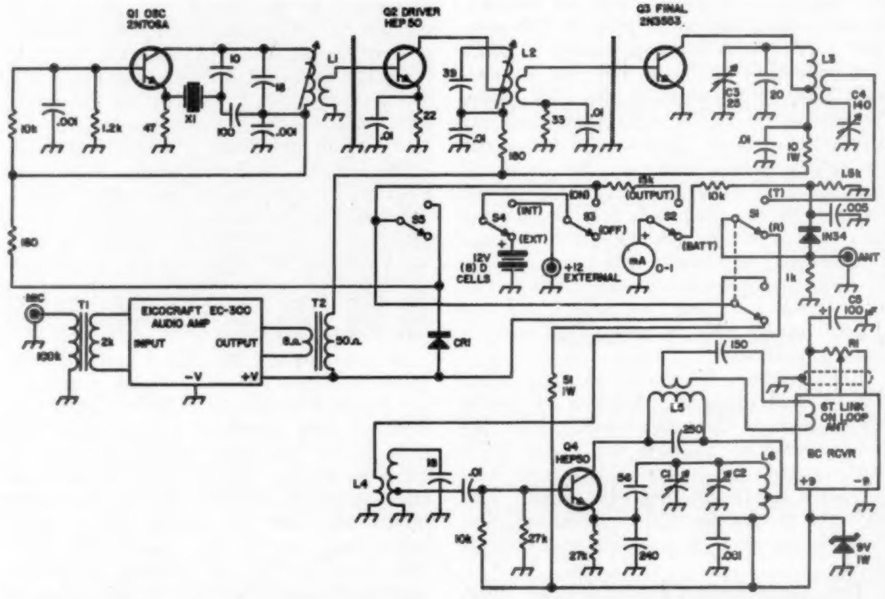

Q1 OSC
2N708A
Q2 DRIVER
HEP 50
Q3 FINAL
2N3553
10k
.001
1.2k
47
X1
10
18
100
.001
L1
.01
22
39
.01
L2
180
33
.01
C3
25
20
L3
C4
140
.01
10
1W
180
15k
(ON)
(OUTPUT)
10k
(T)
1.5k
.005
S5
S4
(INT)
(EXT)
S3
(OFF)
S2
(BATT)
S1
(R)
IN34
ANT
12V
(8) D
CELLS
+12
EXTERNAL
mA
0-1
1k
C5
100
MIC
T1
100k
2k
EICOCRAFT EC-300
AUDIO AMP
INPUT
OUTPUT
–V
+V
T2
8Ω
50Ω
CR1
150
R1
51
1W
L5
6T LINK
ON LOOP
ANT
250
BC RCVR
+9
–9
Q4
HEP50
L4
18
.01
56
C1
C2
L6
10k
27k
27k
240
.001
9V
1W

Fig. 1. Schematic diagram

Here is one way to get on six meters without spending a lot of bucks. In the process you can have a lot of fun building your own rig and, if you are one of the uninitiated, take the plunge into transistor circuitry.

You have probably already looked at the transceiver diagram, **Fig 1**, and I expect that your reaction was "boy, that looks simple." Well, this rig was intended to be simple and inexpensive. The transmitter power input was kept low—2 watts—more than adequate to give good local coverage. The low power also means the rig can be run off Size "D" flashlight batteries keeping the weight down (5½ lbs.). This along with the small size makes it a dandy rig for portable and/or emergency use. An rf amplifier was not used ahead of the receiver mixer in order to keep the cost down. The rf amplifier is not needed for local activity anyway.

General construction

The transceiver is built in two 7 x 5 x 3 aluminum miniboxes (Bud # 3008A) butted back to back so that you end up with a front and rear compartment. The front compartment houses the converter, transmitter, modulator and has all of the controls, with the exception of the power selection, mounted on the cover. The microphone socket, on/off volume control and spot switch are mounted on a small bracket positioned so they protrude thru the front panel when it is assembled to the front minibox. The rear compartment houses the BC receiver, modulation transformer and battery pack.

The power selection switch and socket for external power are mounted on the rear cover.

The antenna socket is mounted on the top right end of the front box. Two holes near the antenna socket allow access to the transmitter amplifier tuning and loading controls.

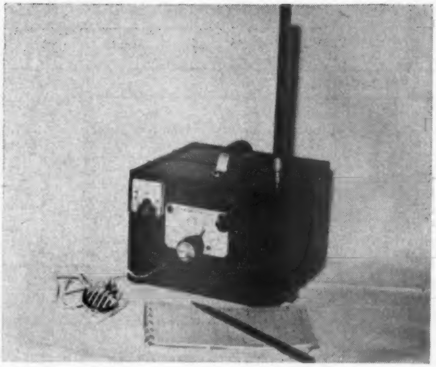
The only luxury in the transceiver is the meter that is used to measure either battery voltage or rf output depending on the setting of S2. Actually the meter is well worth the investment considering the speed it allows in determining battery condition and ease of transmitter adjustment with different antennas.

S1 switches the transceiver between transmit and receive mode. S1A switches the antenna and S1B switches the dc voltage. S5 turns on the transmitter oscillator for frequency spotting.

Chasis layouts are shown in **Fig. 2** for the converter and transmitter exactly as I built them. They are the only units that may be critical in the transceiver and are therefore the only layouts shown. The arrangement of all units as to their position in the transceiver was not found to be critical so a detail layout of the entire transceiver was not prepared. The final locations will probably be determined by ease of operation and by best utilization of space. In any case the two Bud cabinets specified have plenty of room in them.

The receiver

The receiver is made up of two basic parts; a commercial transistor receiver (Japanese variety $5 to $8) and a one transistor, Q4, combination oscillator/mixer/converter. The converter operates on the autodyn principle, L6 setting the oscillator frequency at one half the operating frequency. In this case the oscillator tunes 24.195 MHz to 25.195 MHz to cover the receiver range of 50 to 52 MHz. The output of the converter is approximately 1610 kHz. The transistor receiver is used as the *if* amplifier, detector and audio output amplifier and is tuned to the converter output frequency of 1610 kHz. Coupling between the converter and receiver is accomplished by a six turn link wound over the center of the bc set ferrite loop antenna. This link is connected to the 3 turn link over the center of L5 by a 150 pF capacitor. The 150 pF capacitor prevents any chance of too tight a coupling and subsequent pulling of the bc set oscillator frequency. Do not use shielded wire for the connecting twisted pair.

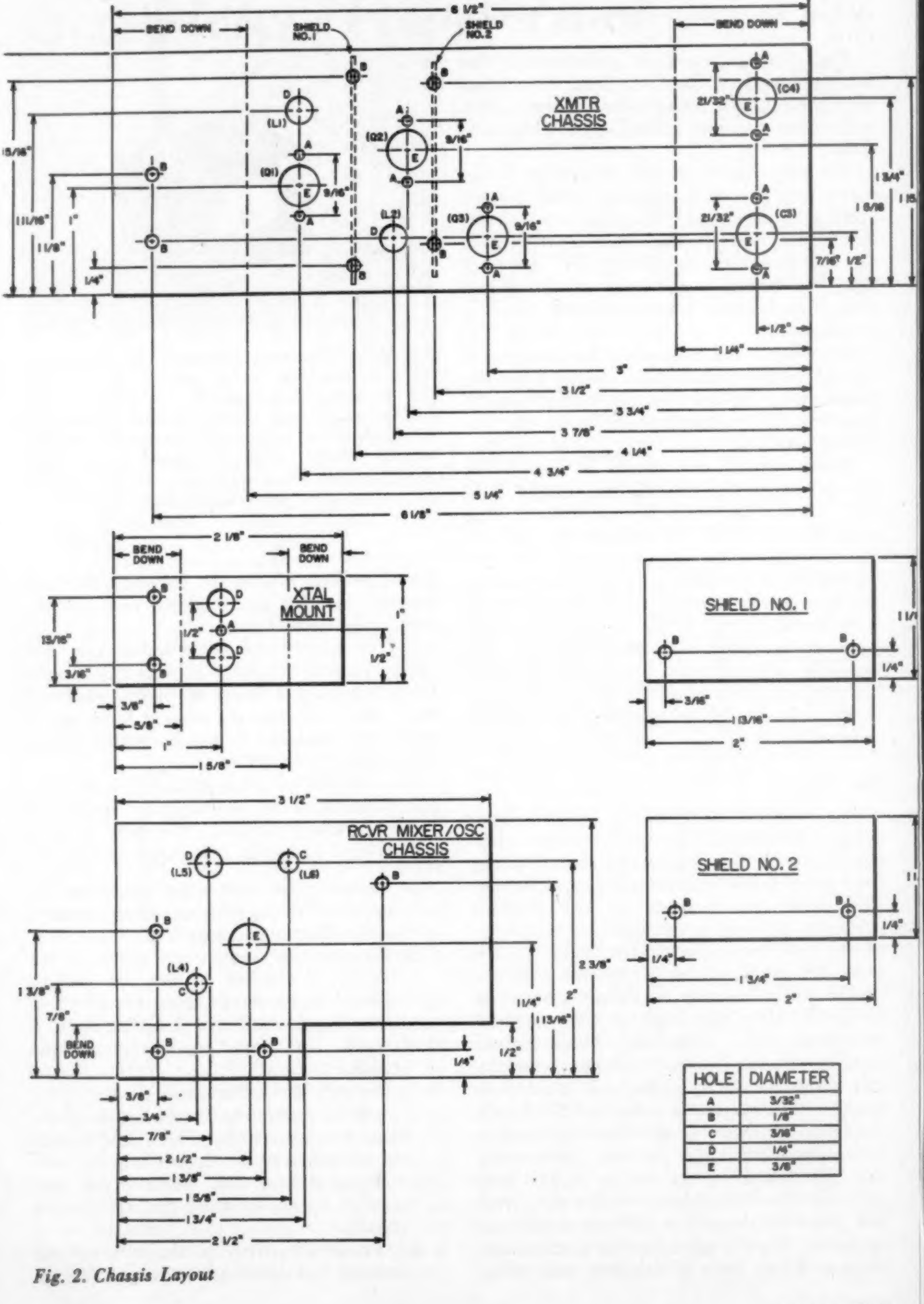


Six Meter Transceiver—Controls, bottom left to right; microphone, on/off volume, spot: center left to right; meter switch (DC-RF), receiver tuning, send/receive switch. Antenna shown is a collapsable "CB" replacement type and is mounted with a PL-259 to Phono adapter. Note crystal mounting thru lower right side. Speaker opening cut in top right rear compartment.

L5 is constructed by winding one full length (about 45 turns) of #26 wire on the form, applying a layer of plastic electrical tape, then winding the second layer of 30 turns. L5 resonates to the converter output frequency of 1610 kHz.

Because the bc set is mounted in the rear compartment it is necessary to install an external volume control. The new volume control and switch is connected as follows:

1. Remove the two wires going to the switch of the old bc set volume control and solder them together.
2. Remove the three wires going to the resistance element of the old volume control and connect them to the three inner condustors of a length (about 8 inches) of three conductor shielded cable.
3. Connect the other ends of the three inner conductors to like terminals of the new volume control. The shield should be grounded to the chassis near the new volume control. The shield is not connected to anything at the end in the bc set.
4. The on/off switch on the new volume control should be wired as per **Fig. 1.**


XMTR CHASSIS
BEND DOWN
SHIELD NO. 1
SHIELD NO. 2
6 1/2"
(L1)
(Q1)
(Q2)
(L2)
(Q3)
(C4)
(C3)
9/16"
21/32"
15/16"
1 11/16"
1 1/8"
1"
1/4"
1 3/4"
1 5/16
7/16"
1/2"
1 1/4"
3"
3 1/2"
3 3/4"
3 7/8"
4 1/4"
4 3/4"
5 1/4"
6 1/8"
XTAL MOUNT
2 1/8"
13/16"
3/16"
1/2"
3/8"
5/8"
1 5/8"
SHIELD NO. 1
13/16"
2"
SHIELD NO. 2
RCVR MIXER/OSC CHASSIS
(L4)
(L5)
(L6)
3 1/2"
1 3/8"
7/8"
2 3/8"
1 13/16"
11/4"
3/4"
2 1/2"
1 3/8"
1 5/8"
1 3/4"

HOLE	DIAMETER
A	3/32"
B	1/8"
C	3/16"
D	1/4"
E	3/8"

Fig. 2. Chassis Layout

Receiver adjustment

Use a grid dip meter to adjust L4 to 41 MHz, L6 to 25 MHz and L5 to 1.6 MHz for a starter. Tune the bc set to a dead spot between bc stations near 1.6 MHz. Because of the lack of shielding in this type of bc set harmonics of the bc set oscillator will be coupled into the 50 MHz converter thru the twisted pair connecting link. With a converter tunning range of 50 to 52 MHz you are bound to get one of those harmonics. By keeping the bc set tuned between 1.6 and 1.62 that harmonic should show up near the 52 MHz end and won't be a problem.

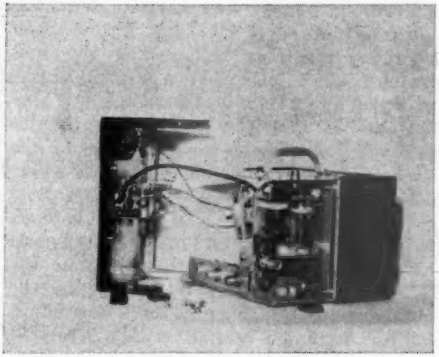
The next step is to couple a signal into L4 and adjust alternately L6 and C1 trimmer until the range of 50 to 52 MHz can be covered by tuning C2.

If you intend to use the entire range of 50 to 52 MHz set the signal source to 51 MHz and adjust L4 and L5 for maximum output from the bc set. If most of your operation will be in the first 1 MHz of the six meter band set the signal source to 50.5 MHz and tune L4 and L5 for maximum output.

The transmitter

The transmitter is constructed on a 4 x 2¼ inch piece of .04 inch thick aluminum with two 1¼ inch lips folded down a both ends. The shields are held in place with spade lugs and have a ⅜ inch hole drilled through them for signal feed through to the next stage.

The oscillator, Q1, uses overtone crystals, feeds Q2 which is a straight thru driver for the final, Q3. Either 2N706's or HEP-50's can be used for the oscillator and driver. The prices aren't bad, $ .99 for the 2N706 and $ .79 for the HEP-50. The final uses a 2N3553 which costs about $4.75. The 2N3553 has a Collector to Emitter Voltage rating of 65 volts which is required for amplitude modulation of the final (with a 12 volt supply the collector voltage on modulation peaks can reach 48 volts). The 180 ohm resistor in the collector lead of the driver Q2 limits the peak voltage to that stage on modulation peaks. With the arrangement shown 80-90% modulation can be achieved. If 100% modulation is required the 180 ohm collector lead resistor to Q2 can be eliminated, however, Q2 will have to be replaced with a transistor that will handle the 48 volt modulation peaks. On the air checks with other stations indicate that the modulation, as set up in Fig. 1, was adequate. Both Q2 and Q3 require heat sinks.



Front compartment with "U" cover removed showing; 1. In lower center the bracket used to mount the microphone jack, on/off volume control and spot switch, 2, on right the transmitter mounting and crystal mounting bracket. Note the modulator printed circuit board mounted on compartment back just behind the transmitter, 3. center left the converter sub chassis.

The transmitter was mounted in the front compartment with the bottom or wiring side facing to the right. This allows access to the circuitry for checking and possible trouble shooting after the chassis is mounted. The coil slugs are accessible thru the bottom of the forms. An insulated tool should be used for tuning. A bracket is formed for the crystal socket. This bracket mounts on the bottom of the transmitter chassis over the oscillator wiring and makes it possible to change crystals thru a hole cut in the right side of the cabinet.

L3 is a self-supporting coil made of #18 wire. The two turn link is made of #22 solid insulated wire. The link can be best made by taking two turns around the shank of a ⅜ inch drill then twisting the ends of the wire a couple of times next to the turns. The link is inserted between the 1st and 2nd turns of L3 from ground end and is held in place with a couple of drops of glue.

Transmitter Adjustment

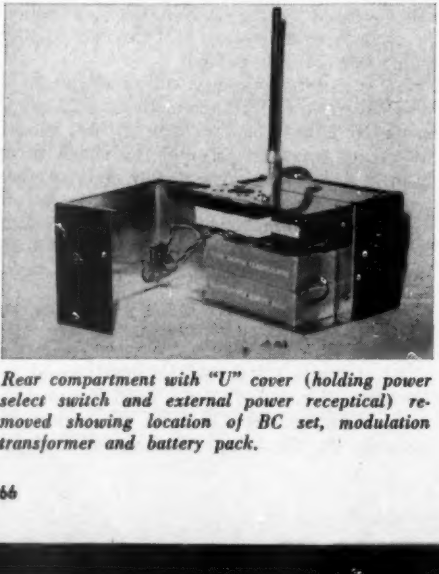
L1, L2 and L3 should be grid dipped to 50 MHz. If you can't get a good dip on L2, temporarily remove Q3 from it's socket. If possible do the initial tune up with a 10 volt supply. There is less chance of damaging the transistors at that voltage. Apply power to the oscillator by depressing the spot switch S5 and check with a grid dip meter to make sure Q1 is oscillating. If Q1 does not oscillate adjust L1 until it does. At this point you should be able to tune in the oscillator signal with the converter whenever S5 is held depressed.

Connect a dummy load to the antenna jack. This can be a 51 or 75 ohm 2 watt resistor. Turn S1 to transmit and tune L2, C3 and C4 for maximum reading on the output meter M1. Then go back and adjust L1 for maximum output on M1. Turn S1 back and forth between transmit and receive several times to make sure L1 is adjusted properly for easy oscillation.

The modulator

The modulator is an Eicocraft EC-300 2 watt autio amplifier kit and sells for $4.95. At that price it is hardly worthwhile to design and build your own. The input impedence is 2k ohms and is matched to a high impedence crystal mike by T1. T1 isolates the amplifier common, which is at a plus voltage, from the transceiver ground system. No form of gain control was needed as the amplifier output was just right with it running wide open. The microphone used with the transceiver is a lapel mike (Lafayette 99H4510) and does a pretty good job for $1.95.

The output of the amplifier is 8 ohms and is matched to the approximately 50 ohm input of the final by reverse connecting a Knight 54B4149. The common and 8 ohm tap connect to the amplifier output and one side of the secondary, and center tap are used to obtain 50 ohms for feeding the transmitter.



Rear compartment with "U" cover (holding power select switch and external power receptical) removed showing location of BC set, modulation transformer and battery pack.

The Eicocraft comes with mounting screws and spacers. This hardware is used to mount the circuit board to the rear of the front compartment behind the transmitter chassis. The spacers provided are not very long so care should be used to make sure all leads on the bottom of the circuit board are trimmed closely.

Conclusion

The converter tuning capacitor is fitted with a Jackson Bros. #4511 vernier drive for smooth operation (available from Arrow Electronics Inc.). The dial plate is a piece of .04 inch thick aluminum 2 x 3 inches that was painted and numbered by using Datak instant lettering.

the transceiver has a built in power supply of 8 series wired Size "D" flashlight cells. A switch and socket is mounted on the rear cover so that an external power supply can be used. This could either be a car battery (plug in cigarette lighter) or a 115Vac supply. If continued portable use is anticipated it would be worthwhile to invest in Nickel Cadmium batteries and build a charger.

Power consumption under three different voltage inputs are:

Voltage	Total input	Final input
10	.35 amp	.18 amp
11	.40 amp	.22 amp
12	.45 amp	.24 amp

In receive mode the transceiver draws between .04 and .05 amp.

The transmitter output circuit is designed for 52 to 72 ohms and can be operated with either a whip for portable use or a beam. A whip should only be used when necessary because of the limited coverage. If a portable beam is not available when operating portable, say from a mountain top, a long wire with a simple tuner will work out much better than a whip.

So there you are—if you want to get your "feet wet" on transistors and also get together with the gang on the local six meter net go to it. I'm sure you will get as much fun and accomplishment out of it as I did.

. . . W2AJW

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After oiling, rewind onto the first spool without adding any more oil. Keep the ribbon fairly tight on the spool as you wind. This tends to force the oil into all parts of the ribbon and distributes it evenly.

Now replace the ribbon in the machine and test it by typing with it. If you have too much oil on the ribbon it will type rather messily, but if not enough oil it will print dimly.

Another tip: ribbons which are used in adding machines, posting machines and other office machines other than typewriters seem to be of better quality and last longer than regular typewriter ribbons. Most users of these machines will give you their discarded ribbons. Since adding machines and such use only one half of the ribbon anyway, a discarded ribbon still has half of its useful life ahead of it. When purchasing a new ribbon it would be good economy to buy one designed for adding or posting machine service.

Joe Wright W5AQN

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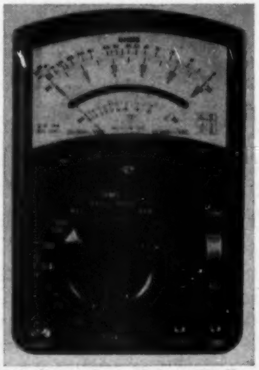

DC Volts: 2.5, 50, 250, 500, 5000. AC Volts: 10, 50, 250, 500, 1000. OHMS: 1K, 10K, 100K, 1M. DC mA: .05, 50, 500. Decibels −20 to +62 db. Few small VOM's read up to 5000 volts, yet this is just what you need for testing your rig. 3" meter with mirror for high accuracy of readings. This meter has both the low scales and sensitivity for checking transistor circuits as well as the high ranges for transmitters. Buy one for the shack and one for the car. Light and rugged for traveling.

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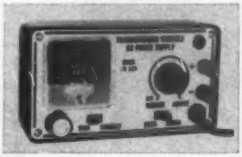

This power supply will operate transistor radios and other devices under repair or where batteries are a drag to replace. Voltage range: 0-20 vdc continuously variable. Meter ranges: 0-20 vdc, 0-20 mA, 0-200 mA. Maximum current capacity: 150 mA/20 v or 200 mA/10 v. Pilot lamp. AC ripple: less than .25 mv rms. Fused. Has built in power transformer and 30 watt power transistor. Built for continuous duty.

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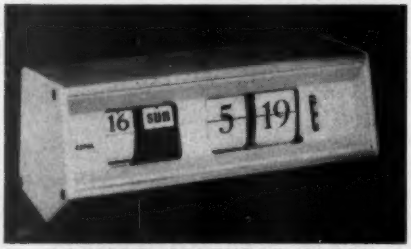

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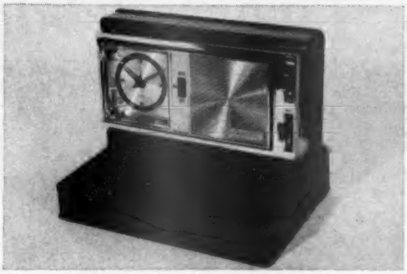

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Two Sidebands From The TWOER

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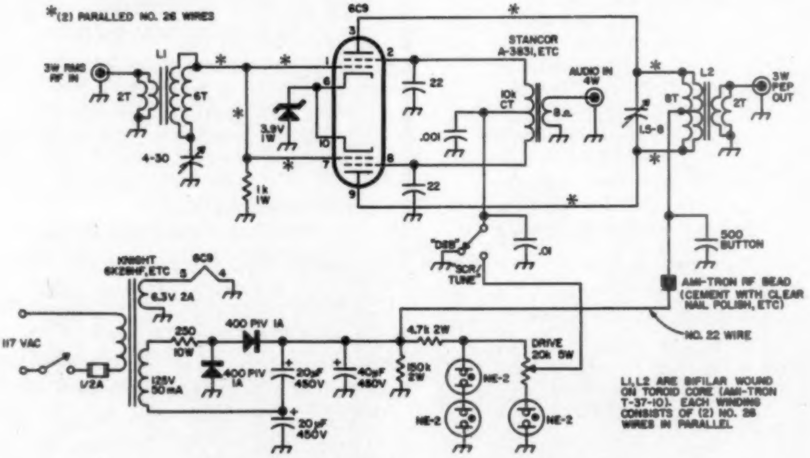

*(2) PARALLED NO. 26 WIRES
3W RMS RF IN
L1
2T
6T
4-30
1k 1W
3.9V 1W
6C9
1
2
3
6
7
8
9
10
22
22
STANCOR A-3831, ETC
10k CT
8Ω
.001
AUDIO IN 4W
LS-8
L2
8T
2T
3W PEP OUT
"DSB"
"SCR/TUNE"
.01
500 BUTTON
AMI-TRON RF BEAD (CEMENT WITH CLEAR NAIL POLISH, ETC)
NO. 22 WIRE
KNIGHT 6K28HF, ETC
5
4
6.3V 2A
117 VAC
1/2A
125V 50mA
250 10W
400 PIV 1A
400 PIV 1A
20µF 450V
40µF 450V
20µF 450V
4.7k 2W
150k 2W
NE-2
NE-2
NE-2
DRIVE 20k 5W
L1, L2 ARE BIFILAR WOUND ON TOROID CORE (AMI-TRON T-37-10). EACH WINDING CONSISTS OF (2) NO. 26 WIRES IN PARALLEL

Fig. 1. Diagram showing all parts and connections.

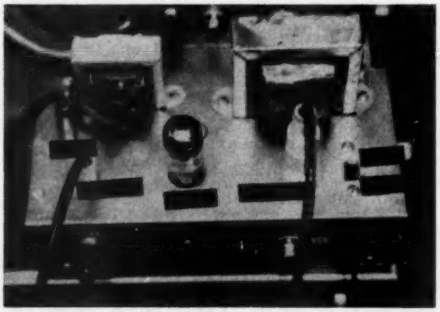
This article tells the story of a simple way to build a 2 meter sideband rig. All you need is a Two'er or similar piece of equipment, furnishing 2 or 3 watts of rf output; and a 5 watt amplifier, such as the Lafayette KT-92. A mike preamp will help you get 4 or more watts output from this.

The double-sideband output of the unit described is nominally 3 watts PEP. If you are careful, there is enough power available for driving an Amperex 4CX250 or similar beam tetrode using a shielded, high-Q input tank circuit. If you're driving two of these tubes add a 6360 in class AB_1 (or B) as an intermediate power amplifier and use the drive control as we have outlined here. As a sort of rule-of-thumb, this unit will supply about 1 RMS watt to the grid of the next stage. Also, do not feel that you will be losing something by going to DSB! That's not the case. With the 6C9 balanced modulator you can select either high efficiency, well modulated AM, or DSB with real punch!

The operating classes are AB_2 for AM carrier plus screenfed audio (AB_1, if you don't drive it so hard); and class B for the DSB mode. Incidently, AB_2 linear operation is possible with the Two'er, but not recommended since there is "multiplied hum" and fragments of 60 Hz ac present in the output. We do not make DSB out of existing AM from the Two'er, in case you're wondering. Separate audio derived from the 12AX7 and 6AQ5 in this commercial unit will not have enough power as when an outboard audio amplifier is used. Try it though, if your curiosity is not satisfied. With just one tube and an audio amp, you'll soon be known as a "genius" if you get on 2 meter DSB without some 47 different kinds of transverters and a degree from No-Hope-Tech! We *do* use a zener diode if you want to bamboozle 'em a little. Operation is, as we said, either AM or DSB with some grid current being drawn.

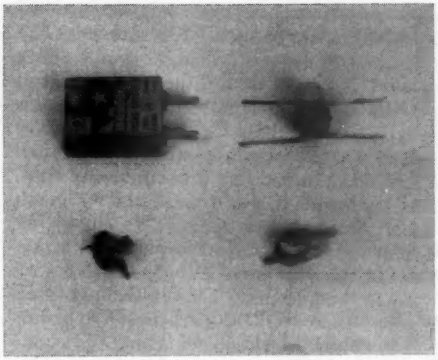
Negligable distortion is present when a 1000 ohm 1 watt composition resistor swamps the grid input winding, but it is necessary to go to 2 watts when driving the modulator with more than 5 watts dc input to the preceding stage. And, probably a higher-valued zener, such as the HEP-103 will be necessary. Here we use an International Rectifier 1 watt 3.9 volt job. Incidently, the correct class A bias for the 6C9 is about minus one volt, so for DSB driving the tube with rf at an average value of −4 volts is quite acceptable. Peak-to-peak swing is about 9 volts, with no more than a small fraction of a peak in the positive grid region. Power in excess of 3 watts will be dissipated chiefly by the control grid (when driven positive), so watch it when using anything larger than a Two'er for drive.

An interesting point is that there is negative current feedback, or degeneration, through the zener for negative audio peaks and this tends to improve the audio fidelity; rf having been safely bypassed to ground through junction capacity. On AM mode screen modulation, using a Cesco Reflectoometer in the output line as a tuning/SWR device; we see upward modulation when flat-topping the audio in class AB_2. Simply reduce the audio gain to a point where only when shouting into the mike at 2 inches will produce this symptom (use a dummy load): then relax and talk normally, and no one will know that it is zener offset positive peaked AM!! Of course a scope will come in handy here for setting it properly!



Construction

The first photo shows parts placement on the bright nickel plated steel chassis, with the screen voltage or drive control on the left. Just behind this pot on top of the chassis is an rf coax termination, using approximately 1 yard of RG-58/U coax cable attached to the phono connector output of the Two'er. The Two'er was previously wired for driver plate current to flow through the 350 ohm dc coil desistance of the Dow-Key DK-60 send/receive relay, with the 1000 ohm internal dropping resistor removed. This way, the switch on Two'er panel serves as *the* control for all circuits and external contacts on the DK-60 relay open the speaker return on transmit: of the *if* strip used.

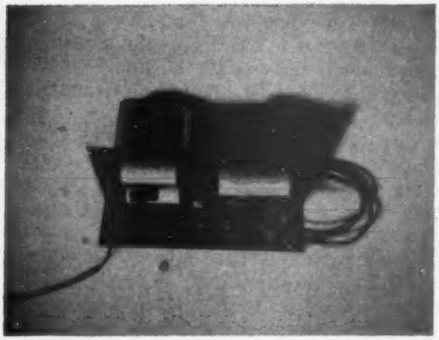


Getting back to the modulator. Just behind the termination is an audio input connector patching the KT-92 amp into the VC to 10K CT 5 watt Stancor A-3831 audio transformer. With the tap on the transformer set to a nominal 8 ohms will give good quality audio (almost broadcast quality) if you don't overdrive it! Also, for improved fidelity it is desirable to feed 4 ohm output (or 3.2) from the amp into 8 ohms, but not vice versa, with a power loss. Please note also that if you're using a KT-92: this is an ac-dc type amp with floating ground and plug phasing is important to avoid electrical shock when used with other grounded equipment. Remove the Two'er audio section, after experimenting, to prevent weird results using the balanced modulator in DSB with AM on what is left of the phased-out carrier. Yanking the tubes out (carefully) will do this. Next we see the 6C9 tube in the center with the power transformer behind and a type 60P UHF panel receptacle.

The next photo shows the miniature toroidal tank circuits before they were mounted to the chassis underside with epoxy cement. An FT-243 crystal holder is used to reference the size of the components involved. The left (L1) tank is a bifilar 6 to 2 of #26 Beldsol wired toroid, with an Erie 15-60 PF N1500 trimmer capacitor; and is tuned only by the 2 turn series input capacitor just mentioned, which makes the left (grid) winding into a form of autotransformer for rf. Later on the Q dropped in this circuit with mechanical tuning adjustments: so we went to an 822EN CRL trimmer. The righthand (L2) tuned circuit uses another toroidal rf tank, wound on an Ami-Tron T-37-10 core, push-pull balanced to single turn output coupling. Both tanks are bifilar wound. Do not use wire any heavier than #24 Beldsol or you *will* break the core! And, it is academic if you'll raise the Q much higher with bigger wire, because circulating current losses may defeat any gain over skin effect at these frequencies.

An important thing here is that we used material type #12* (Carbonyl SF) cores purposely to "keep the field within the core," at a reasonable Q, compared with air-winding, so that shielding would be unnecessary in this unit; and the leads to and from the toroids are much shorter than would be the case with an enclosed trough with removable cover for tuning. It also serves (the cores) to make visible the small Erie 1.5-8.0 pF trimmer for easy tuning with a metal tipped plastic "tuning wand," plus the fact that the size of the miniature components reduces imbalance because of proximity to the chassis lid or front apron, from the inside.

By keeping the "field within the core," we save space, reduce radiation loss (high specific inductivity of 7.43), make the trimmers accessable for tuning without a cover removed, and have shorter leads to the tube. There are no fancy balance controls nor do you see half your power output drop off by removing lid of the Bud CU-482 convertabox! Perfectionists will find that increased balance for a sharper carrier null (more than 20 dB, as observed), can use a JAN type "place-over" shield base over the 6C9 tube socket; and with the unit operating DSB mode, move same eccentrically around-and-about the tube looking for decrease in output, on the reflectometer in forward position with maximum setting on level pot.



The last photo shows the underside of the unit, the neon NE-2's and the fullwave voltage charging electroylics and the output filter capacitor. The NE-2's were later replaced with higher current NE-83's for longer life (the 83's are pre-aged) and the same component protection. The purpose of the neon's is two fold: First, the highest dc voltage on the plates is limited to the top firing voltage drop of the two in series (about 220 volts) plus the drop through the 4.7 k 2 W resistor. Second, the operating point is established for the screen by having a voltage limit of only one neon drop at the lower end of the 20 k pot: this gives rather precise control of the modulated AM output in AB_2. Without the neon's, cathode bombardment may result from the excessively high plate and screen voltages when *not* transmitting or driving with some rf signal, but leaving the mode switch on DSB.

Use

We had trouble, at first, with the Two'er apparently going "spurious;" where the 72 MHz multiplier stage began leaking through the low-Q of the output tank; radiating a 1.5 microvolt signal around town on channel 5. Meck Brazelton, W4JSH, phoned me about it (since he is our local TVI expert), and we thought that this was an image on his new Amphenol Field Strength Meter. But it wasn't! The Two'er output was the cause (ceramic trimmer loosened-up). After this was corrected, we were much cleaner than a nearby Ameco TX-62; and had more 2 meter output.

Stability

The Two'er is crystal controlled and has an output frequency 18 times the fundamental of 8 MHz. Coincidental with the multiplier leak-through mentioned above, we had severe drifting (3 kHz in 10 MIN) which was cleared up with the new trimmer. Art, WB4ENO, helped check this with his new Interceptor receiver. There was some drift over a long period of time; but after a long warm-up this was minimized. We tried W4JKL's idea for "A Low Cost ac Regulator," described in January 1967 *73*, which improved things. With the Two'er, audio tubes must be removed to lighten the load, and a 10 watt bulb worked better than 60. Incidently a similar series current regulator for a dual 30 watt draftsman fluorescent lamp has been in use here for 3 years, with no lamp replacements yet!

---

*Available from Permacor, 9540 S. Tulley Ave., Oak Lawn, Ill.

Using the KT-92 amp at the full five watts was not necessary. Only about 3 watts were needed to fully modulate 2 watts of rf. Negative peak degeneration allowed this to be; as it is possible in certain cases to use as much audio as rf, power-wise, if you use positive peaks of audio and dissipate maybe ½ watt in the zener impedance of 10 ohms: not overlooking the ½ watt audio dissipated on the screen, itself.

In designing the 6C9 balanced modulator, we chose the rf quiescent point to be fixed at about 2 volts negative (3.9 volt zener) average value; and the dynamic audio screen impedance was figured to be 15 K ohms, when viewed by the secondary winding, of a 10 K CT audio transformer at four watts. It takes a montrous amount of speech to make the unit flat-top; however, it will do this, even though theory says not! Not at least with screen-fed AM. The best way to set your amp level (and/or preamp) is to use an oscilloscope. Don't worry about DSB and AM being non-compatible! You can initiate QSO's on AM and then just flick a switch to go to DSB.

Traces

Using the 6C9 on-the-air has been a pleasure. Most local hams have not tuned DSB before, and several thought we were flat-topping AM or splattering, until it was explained that they should use their BFO. Oscilloscope traces were made of both screen modulated AM output and DSB, at the same setting of the KT-92 amp gain. It was interesting to see that regular AM had a zero reference line which could be interpolated by visual averaging, in the center; whereas DSB demodulated was like the speech waveform was "all positive or all negative" going; all good quality carrier-less random audio waves, because no carrier was injected in the demodulating probe used. To listen to it on a 'james dandy mixer, improved," was to hear the usual, muffled FM type sound on a Brush Clevite brand hi-z crystal earphone. There was a huge increase in level when switching to DSB, as theory would say = 8 dB.

For the engineers in our midst, I'd like to say that the method used here to create a DSB signal is pretty sound, we think, since the control grids of the 6C9 comprize most of the input capacity for the whole tube; neglecting Miller Effect, so that there is a small imbalance on these inphase electrodes, that very difference compared with the absolute value of the total input capacity is a very small percentage.

Conclusion

In this article we've seen the possibility of low-cost sideband for amateur use in the VHF bands, where it doesn't matter about which sideband is in use! This design can be adapted for 220-225 MHZ and maybe 432 MHZ with 787 Nuvistor tetrodes! There's really nothing to it, as they say, but start with equipment that doesn't cost too much . . . And start experimenting. If you can get "on," at all with home-brew, this unit should remove some of the hazy ideas you may have had about sideband on VHF. Note that the Two'er output is convenient for driving a varactor for extrapolated UHF design. Finally, the 51J4 set of listeners will have something new to tune, when you get on! . . . W4KAE

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Getting Your Higher Class License

Part VI — More on Transmitters

Last month we observed that operation of a ham station involves three major items—a transmitter, an antenna, and a receiver.

In this section of the study course for the new Advanced Class license examinations, we're going to take up the second of three groups of questions dealing with transmitters.

The questions from the FCC study list which we'll be dealing with this month are as follows (the numbers are those assigned in the FCC study list, in case you're checking them off as we go):

19. When is an amplifier operating Class A? Class B? Class C?
20. What happens to even-order products in rf linear amplifiers?
23. How are bypass capacitors used How should their impedance compare to the elements they shunt?
24. How can TVI caused by cross-modulation be remedied?
27. What circuit factors affect the peak envelope power to a transmitter?

Since it's our aim to provide you more than just a list of answers to memorize, we'll follow our normal procedure of paraphrasing all these questions into broader, more general questions covering the same material. If you can answer the more general questions, you should have no trouble at all with the study-list questions—or with those on the actual exam.

The first question of this month's group deals with the classification of amplifiers. Let's rephrase it into the general inquiry, "How are amplifiers classified?".

The second deals with the action of even-order products in rf linear amplifiers. The more general view is, "What are 'products' in amplifiers, and what happens to them?"

The third deals with bypass capacitors and their impedance. Let's make it a little more general by asking, "How can signals on the same wire be separated?"

Number four asks specifically about TVI caused by cross-modulation. Let's generalize it by asking, "What is cross-modulation and how can it be prevented?"

Finally, instead of the detailed discussion of circuit factors affecting peak envelope power, let's find out "What determines the power output of a transmitter under any conditions?"

Ready? Let's go!

How Are Amplifiers Classified? Maybe this question should begin by asking, "What is an amplifier", because many different kinds of devices can amplify—and an amplifier is anything that amplifies.

Four our purposes, though, we can limit the definition of "amplifier" to "a circuit using either vacuum tubes or transistors which accepts as input an electrical signal, and produces as output a second electrical signal which is at every instant proportional to the input signal."

You might say that's not much of a limit, since the output signal can be either greater or less than the input signal—but some "amplifiers" produce voltage loss rather than gain, and a definition must be broad to encompass these too.

One way of classifying the things fenced in by this definition would be as "vacuum-tube" or "transistor" amplifiers, and you will frequently find these classifications used.

Another way would be by the kind of signals handled; this would include such classifications as "audio", "rf", "dc", "if", and "ac" amplifiers. This method of classification, also, is popular.

As it happens, though, a system of classification based upon the amplifier's operating conditions can cut across all other classification systems. This system, which parcels all amplifiers into either Class A, Class B, or Class C, has a unique advantage in that the A, B, or C classification tells you quite a bit about the amplifier's signal-handling characteristics.

If only one such system were in general

use we would have little to discuss here. Unfortunately, a number of systems—all differing in at least one detail from all the rest—use the same A, B, C classifications. If you have learned only one of these, you may find that you're not talking about the same thing as the other guy even though you're using the same words.

For instance, a Class A amplifier is sometimes defined as an amplifier in which current flow in the output circuit remains constant during the operating cycle. This definition cannot be correct—if current flow remained constant at all times, no signal could be developed! If this definition is modified to read "average current flow", then it's okay.

But other authorities define a Class A amplifier as one in which current in the output circuit is never cut off during the operating cycle.

This definition, too, is okay—but it isn't consistent with the first. That's natural, since we're dealing with two different classifications systems that just happen to use the same names.

Still another definition frequently used for a Class A amplifier is "one in which gain remains constant"; a fourth requires that the amplifier be distortion-free.

Before we get completely confused, let's turn and look at definitions for Class B. The system which defines Class A operation as "constant average current" defines Class B as "average current varrying". That which calls Class A "current never cut off" class Class B "current cut off for less than half the operating cycle". That which calls Class A "constant gain" calls Class B "varying gain", and that which calls Class A "distortion-free" calls Class B "low-distortion".

How about Class C? In order, it may be defined as "extreme current variation", "cutoff for more than half the cycle", "all-or-none gain", or "highly distorted".

With all these different sets of definitions running around, how are we ever going to come up with an answer which we can consider to be the *the* right answer—or can we?

The answer is yes, we can, because all of these various systems of classification are attempting to describe the same general concepts, and the apparent differences are more in the words chosen to describe the concepts than in the concepts themselves.

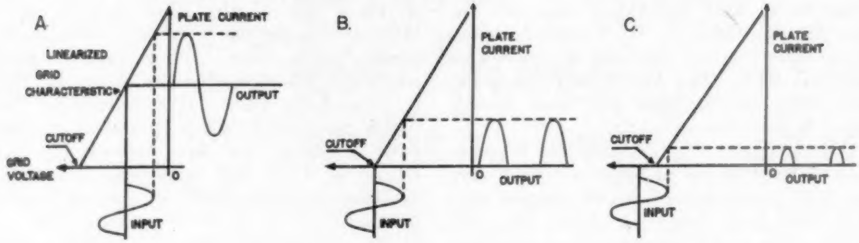
Before we get into our attempt to bridge this particular communications gap—and it *is* a major gap—let's take note of a couple of facts. All of the four systems we've sketched out use the A, B, or C letters to indicate "pure" cases, and in practice most amplifiers fall somewhere in between. This is particularly true of the boundaries between class A and Class B, and as a result most amplifiers we meet in real life are known as Class AB amplifiers. These are a little of both, and so are exclusively neither!

The concept of a Class A amplifier is that of an "ideal" amplifier in which any input signal is faithfully reproduced at the output, without distortion. In a perfect amplifier, this normally would require that current keep flowing throughout the entire operating cycle (since all devices are imperfect at the extreme limits of their operating ranges, and to be perfect we would have to avoid the imperfect regions), and that the average current flow be constant (if the input signal is symmetrical). Gain would also be constant. Thus all the definitions merge into one—for a perfect amplifier.

The concept of Class B operation is again based upon a perfect circuit, in which non-linearity would be impossible. If the current is biassed precisely to the point at which output-circuit flow ceases, then any positive-going input signal would permit current flow in the output circuit. Since we defined the circuit as "perfect" and without any non-linearities, as soon as current flow is permitted the amplifier is producing its normal gain. This in turn makes the output signal a replica of the input signal—but only for the half-cycle of input signal which permits current flow.

Current flow in this arrangement is for exactly one-half of the operating cycle. As a result, average current flow would fluctuate with the signal level—stronger signals would draw more current, on average, than weaker ones. Gain would vary from zero when the amplifier is cut off to normal when it is turned on. And distortion would be 50%; none when the amplifier was on, but total when it was cut off.

In practice, of course, it's almost impossible to keep the bias at the exact point to permit current flow for precisely one-half cycle. Even were it easy, tubes and transistors have such high distortion at low current that proper operation would be difficult. For this reason, in "Class B" designs



Class A—Output is replica of input current flows throughout cycle

Class B—Output is only half of input current flows for only half cycle

Class C—Output is like input only in timing current flows for less than ½ cycle

Fig. 1—Transfer curves (with idealized transfer characteristic) illustrate differences between Classes A, B, and C. Actual amplifiers never have sharp break at cutoff, so ideal operation shown here can never be realized. Practical amplifiers do come close to this, however. For illustration, all input signals are same amplitude. Class C circuits are normally overdriven to achieve full efficiency.

bias is set so that current flows for more than half a cycle, but less than a full cycle. In some designs it always flows, but varies widely over a cycle; both these variations are, technically, Class AB operation.

Finally we have the concept of Class C operation. One authority has described this, very accurately, as "switching" operation. The tube or transistor is completely cut off most of the time, and is "switched" on by the most positive peaks of the input signal. When "on", it acts like a closed switch and conducts as heavily as it can. The output is a series of current pulses, each corresponding with the tip of an input signal.

Current flow in this circuit is appreciably less than half an operating cycle, and is either all or nothing at all. Gain, similarly, is "infinite" when the amplifier is "on", and zero when it is "off". Distortion is almost total; those input signals which are strong enough to turn it "on" turn it all the way "on", and those which aren't, leave it "off".

You may notice that in the description of these three concepts we haven't mentioned "grid current", although quite a few persons tend to believe that the flow of grid current is connected directly with the A, B, or C classifications of an amplifier. They use the condition of "no grid current" to define "Class A", and "grid current" to define "Class C", then defining "Class B" as the region between A and C.

However, it is quite possible to design a Class A amplifier in which grid current is permitted to flow, and quite a few Class C circuits without grid current have been built since the high-perveance TV horizontal-output tubes became popular. Presence or absence of grid current is normally indicated by a subscript on the classification, such as AB_1 or C_2; the "1" indicates no grid current, while "2" shows that grid current flows.

In actual fact, though, the grid-current condition has nothing to do with the operating classification. Class A amplifiers may be A_1 or A_2, and Class C circuits may be either C_1 or C_2. The effective classification criterion is the duration of current flow in the output circuit.

Class A amplifiers are used almost exclusively when low-distortion amplification is needed, as in audio circuits or low-level SSB generation. Most receiver circuits are Class A.

Class AB or B amplifiers are widely used to deliver moderate amounts of power, with limited distortion. The audio output stages of many PA amplifiers and almost all hi-fi installations operate in Class AB. Similarly, almost all SSB final linears are either AB or B. In audio, use of class AB or B requires a balanced (push-pull) circuit in order to cancel out the inherent distortion. When rf is being amplified, distortion of individual cycles is not important so long as the *envelope* of the signal is faithfully reproduced. A properly adjusted amplifier will do this, and so an unbalanced circuit may be used.

Class C amplifiers are limited to rf power amplification in which envelope distortion is not important. This, in turn, prohibits their use for SSB or AM amplifiers, although if high-level modulation is employed all the rf stages of an AM transmitter may operate Class C since modulation is applied only at the output of the final stage. The major advantage of the Class C amplifier is its relative efficiency; Class A amplifiers normally produce about 1 watt out for every 4 watts dc input. Class B circuits may produce as much as 2 watts out for the same 4 watts dc input, but Class C circuits usually produce at least 3 watts and sometimes even more for every 4 watts in.

What Are "Products" in Amplifiers, and What Happens to Them? The word "Product" has become a "magic word" in ham radio. We have "product detectors" and "distortion products", as well as many others. But what are these "products" we keep talking about?

In an earlier instalment of this series we noted that application of two signals to any non-linear element resulted in the production of, not only the original signals, but new signals made up of the sum and difference frequencies of the originals. This "mixing" action is the basis of all kinds of modulation, as well as of the superhet receiver and all common SSB generators.

A "product" is any output signal from such a mixing action. The original signals are "first-order" products, since each represents "one" times itself plus or minus "zero" times the other. The coefficients "one" and "zero" by which the input signals are multiplied produce a sum or difference of "one" whether they are added or subtracted, and this sum or difference represents the "order" of the product.

Similarly, the output signal representing the sum of the two original frequencies is a "second-order" product, since it is "one" times signal F1, plus "one" times signal F2, and one and one make two. The difference signal, on the other hand, is a "zero-order" product, since one minus one is zero.

Keep in mind that the same non-linear element which permits mixing of two input signals also permits just *one* signal to mix with itself to produce a second-order product which is the second harmonic of the single input signal. This second-order product can then mix with the original signal to produce a third-order product (the third

What this means, then, is that in *any* mixing circuit you will never have just two frequencies with which to deal. In addition to the two frequencies you put in yourself, you have many harmonics of each which are generated by mixing action inside the circuit.

Each of these harmonics can mix with each and every other signal present in the circuit, to produce a near-infinite number of "products".

This is *not* just a hypothetical fiction; it actually happens in all non-linear circuits—and virtually all circuits are non-linear to at least some degree.

In a "linear" amplifier we take great pains to reduce the mixing action—in this case we call it "intermodulation"—to the smallest possible degree, but we can never eliminate it completely.

Since it cannot be eliminated, the output could be expected to contain at least small portions of all the possible products from any pair of frequencies present in the input at any time.

In practice, though, only the odd-order products can be found. The even-order products appear to vanish. Why?

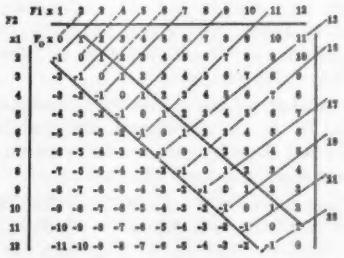


Fig. 2—Difference products for first 12 *harmonics of two tones are shown here. Those products near the original frequency (indicated by* 1 *and* −1 *in the table) cannot be rejected by output tank circuit and so appear in amplifier output. All other products disappear in the output circuit, but may still act as additional tones to create new families of products.*

harmonic), and this process can continue in an infinite loop so long as the new harmonics which are generated by each step are strong enough to be detected.

Fig. 2 shows the reason. In this chart, we're not interested in exact frequencies. We are, however, interested in the *order* of the products produced by two close but not identical frequencies such as those typically present in a voice sideband. We call these two frequencies F1 and F2. In **Fig. 2**, each column represents the products of *one* harmonic of F1, from the first (fundamental) to the 12th, and each row represents the products of one harmonic of F2 over the same range. The column-row intersections contain the number which results when we subtract the harmonic order of F2 from that of F1. As we have already seen, this number (ignoring its sign) represents the order of the corresponding product.

For example, the product formed by the 6th harmonic of F1 and the 4th harmonic of F2, as shown on **Fig. 2**, is of order 2. The "sum" products formed by F1+F2 are not shown.

The diagonal lines in **Fig. 2** represent the selectivity of the output circuit of our amplifier. This tuned circuit can pass most frequencies which are approximately the same as those of F1 and F2, but rejects frequencies which are as much as twice F1 or F2, or as low as half.

Note that all the even-order products are either 0, 2, 4, or higher even numbers. None of these products fall within the passband of the output circuit.

The odd-order products, however, all include at least two products which are of approximately the same frequency as the original signals, and so get through the output circuits. The 5th-order product of either 3xF1-2xF2 or 2xF1 - 3xF2 has an order of 1. The highest-order products shown in this illustration are the 23rd order, and two of these still fall within the passband.

Fig. 3 shows this in more detail for the first nine orders of products. In this chart, all differences greater than the nominal original frequency (FO) are omitted. You can see readily that the even-order harmonics fail to fall within the passband, but all the odd-order groupings have two separate difference frequencies which do come inside the limits and get out to cause trouble.

ORDER	COMPONENTS	DIFFERENCE
2	F1, F2	DC
3	F1, 2F2	FO
	2F1, F2	FO
4	2F1, 2F2	DC
5	2F1, 3F2	FO
	3F1, 2F2	FO
6	3F1, 3F2	DC
7	3F1, 4F2	FO
	4F1, 3F2	FO
8	4F1, 4F2	DC
9	4F1, 5F2	FO
	5F1, 4F2	FO

Fig. 3—This table shows only the difference products near the input frequencies and near DC level for the first 5 *harmonics of two input tones, and illustrates how the product "order" is identified.*

It's especially important to realize that these distortion products cannot be filtered, since they survive in the first place only because they are in the same frequency range as the desired signals. The only way to minimize them is to adjust and operate the amplifier circuit in such a manner as to make it as linear as possible. In such a case, mixing action will be small compared to the amplification, and the unwanted products will be much weaker then the desired signal. Ratios of as much as 50 db between distortion and signal are not uncommon—but overload of the amplifier in an effort to get another watt out to the antenna can make the distortion as strong as the signal.

How Can Signals On The Same Wire Be Separated? Within almost any of our amplifier circuits, we have both dc power for the circuit and ac signal being processed by the circuit present on the same wires. Outside the limits of the circuit, however, we want to keep the ac and dc signals separate. That's the meaning of this question—how can we do it?

The secret of accomplishing this feat of signal separation lies in the fact that ac can be transferred through certain circuit elements which block dc, while dc can go through others which tend to block ac from passing.

For instance, ac will flow through a capacitor while dc will not; on the other hand, dc flows through an inductor while ac is impeded. This is the whole basis of filtering.

Any practical circuit element, of course, has resistance, inductance, and capacitance, all at the same time. This is true even for such a simple element as an inch-long piece of hookup wire! For a length of straight wire all three are very small values—but they are not always negligible. The inductance present in a fraction of an inch of wire, for instance, can be used to tune a bypass capacitor to form a series-resonant circuit, and thus increase its bypassing efficiency.

To separate an ac signal from a dc signal or power flow on the same wire, then, we must separate the wire to form two paths and then place capacitance in one path to limit it to ac flow while placing inductance in the other path to restrict it for dc only.

We frequently use this principle in untuned rf amplifiers, where an rf choke provides the inductance and a coupling capacitor provides the ac path for the output signal.

When we're dealing with an amplifier circuit, both the ac and the dc output-circuit paths must be complete, from amplifier-tube cathode (or emitter) through the tube or transistor to the plate (or collector), and back to the cathode. The desired output signal is coupled to the next stage by either capacitance or inductive (transformer) coupling in most cases, but this doesn't completely satisfy the requirement for a complete path. Some parts of the circuit, for example, must be at ground potential for ac voltages while remaining at high potential for dc—one example is the screen grid of a tetrode or pentode.

The function of a bypass capacitor is to complete such an ac current path by routing the ac directly to ground, yet keeping the dc voltage isolated. Another function for which bypass capacitors are frequently used is that of maintaining ac ground points throughout the power-supply wiring of a unit, in order to prevent undesired coupling between successive stages. And still another function of some bypass capacitors is that of assuring that all rf circuits contain minimum-length current paths, to prevent "ground loops" which can cause undesired coupling between portions of the same circuit.

In order to perform all these functions, the bypass capacitor must appear to be a very low impedance for the particular ac current expected. However, any specific value of capacitance which might be a "very low" impedance for current of one frequency might be a very high impedance for current of much lower frequency. And even if the rated capacitance value represents a low impedance, the physical construction of the capacitor might be such that non-rated inductance could reduce (or even cancel out) its actual capacitance within the circuit.

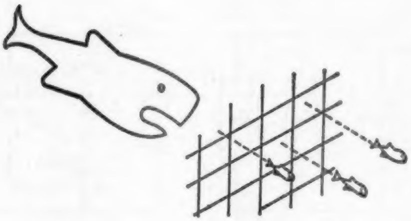


Fig. 4—The problem of separating two signals on one wire is very much like that met by fish-breeders who need to keep the little fish away from the hungry big ones in the same tank. Fish-breeders use a mesh "filter" which the little ones can get through but the big ones cannot. We use impedances to filter signals in much the same manner.

This is the reason that flat or disc ceramic capacitors are so frequently favored for rf bypass use; their construction minimizes inductance. For most rf applications; capacitance values from 0.01 to 0.001 μf are suitable. In critical positions, capacitance values should be calculated—and this requires a knowledge of the dc impedances to be expected in the circuit.

The rule of thumb most often used when calculating the required value of a bypass capacitor's is that the capacitor's impedance should be at least 10 times less than the impedance of the rest of the circuit.

That is, for instance, in a screen-grid circuit supplied its dc through a 1000-ohm resistor, the bypass capacitor's impedance could be any value up to 100 ohms.

This rule is based upon the fact that in a network containing parallel impedances, current flow through each is determined by the ratio of each impedance to the others. The most current will flow through the smallest impedance. If one is at least 10 times less than any other, that one will carry at least 90 percent of the current.

The figure "10" is not sacred in this rule, but represents the experience of some 40 years of engineers. The ratio certainly should not be less than 10-to-1; an even greater ratio offers better bypassing, up to the point at which a capacitor which is so

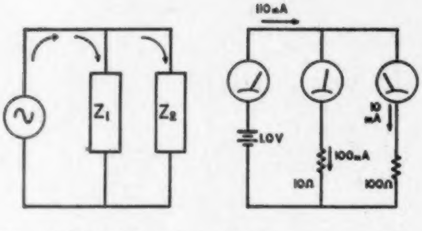


Fig. 5—Principle upon which bypass capacitors work is shown here with generalized impedances (top) and with resistors (bottom). If 10-ohm and 100-ohm resistors are connected in parallel, 10 times as much current flows through the smaller resistor. Similarly, if a low impedance is in parallel with a high one, the low impedance takes most of the current. Bypasses are deliberately-introduced very-low impedances, to "bypass" most of the current away from the rest of the circuit (represented by the higher impedance).

large physically that it begins to lose its effectiveness becomes required.

The filtering or "decoupling" uses of bypass capacitors are not limited to power circuits. They are also widely used in CW keying circuits, for instance, and also (by proper and somewhat critical choice of capacitor values) to bypass rf from audio signal lines and prevent rf feedback into modulators. In every case, the bypass capacitor should offer an impedance to the signal being bypassed which is much lower than that of the element which the capacitor shunts.

What Is Cross-Modulation and How Can It Be Prevented? The term "cross-modulation" is most often heard with reference to TVI, unless you happen to be a VHF addict. In the VHF world, it more often is used with regard to creation of spurious signals in the front ends of sensitive receivers.

No matter which context the term conveys to you, "cross-modulation" is nothing more complicated than our old friend, the mixing action which results when two signals reach a non-linear circuit element.

When the mixing is intentional, as in a superhet receiver, a SSB generator, or a detector, we're happy and then we call it by its proper name, "mixing".

When it's unintentional—as in a distortion-producing amplifier, a case of TVI, or a blocked VHF receiver—we use such names as "intermodulation", "distortion products", and "cross-modulation", as well as many others which won't bear repeating in a publication circulated through the U.S. mails!

But whether intentional or unintentional, the process remains the same. Two signals applied to a non-linear circuit element produce not only the original signals, but a whole host of products as well.

If mixing is intentional, it's usually done within a circuit designed for that purpose—but there's no physical law which requires that the non-linear element be a part of any designed circuit. For instance, a corroded gutterpipe or a leaky insulator on a power-pole guywire may form a sort of happenstance electrolytic capacitor or chemical rectifier, and there's nothing much less linear than a device which changes ac to dc.

That's one of the major causes of "cross-modulation". Two relatively strong signals reach some completely unexpected (and frequently impossible-to-locate) object which happens to be, in addition to its intended use, a non-linear element. There they mix, and all the products are radiated back into space along with the original signals. In the case of TVI, one of the signals may be your own transmitter and the other may be any other transmitter. Neither need be

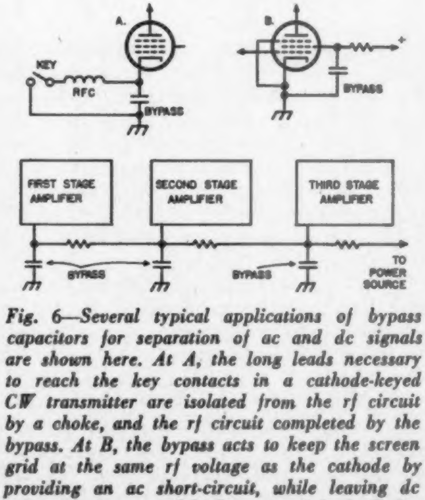


Fig. 6—Several typical applications of bypass capacitors for separation of ac and dc signals are shown here. At A, the long leads necessary to reach the key contacts in a cathode-keyed CW transmitter are isolated from the rf circuit by a choke, and the rf circuit completed by the bypass. At B, the bypass acts to keep the screen grid at the same rf voltage as the cathode by providing an ac short-circuit, while leaving dc voltage at its normal higher potential. At C, bypasses at each stage decouple the various stages by keeping ac signals off of the common power-supply leads.

	F_1	$2F_1$	$3F_1$	$4F_1$	$5F_1$
F_2	F_1+F_2	$2F_1+F_2$	$3F_1+F_2$	$4F_1+F_2$	$5F_1+F_2$
	F_1-F_2	$2F_1-F_2$	$3F_1-F_2$	$4F_1-F_2$	$5F_1-F_2$
$2F_2$	F_1+2F_2	$2F_1+2F_2$	$3F_1+2F_2$	$4F_1+2F_2$	$5F_1+2F_2$
	F_1-2F_2	$2F_1-2F_2$	$3F_1-2F_2$	$4F_1-2F_2$	$5F_1-2F_2$
$3F_2$	F_1+3F_2	$2F_1+3F_2$	$3F_1+3F_2$	$4F_1+3F_2$	$5F_1+3F_2$
	F_1-3F_2	$2F_1-3F_2$	$3F_1-3F_2$	$4F_1-3F_2$	$5F_1-3F_2$
$4F_2$	F_1+4F_2	$2F_1+4F_2$	$3F_1+4F_2$	$4F_1+4F_2$	$5F_1+4F_2$
	F_1-4F_2	$3F_1-4F_2$	$3F_1-4F_2$	$4F_1-4F_2$	$5F_1-4F_2$
$5F_2$	F_1+5F_2	$2F_1+5F_2$	$3F_1+5F_2$	$4F_1+5F_2$	$5F_1+5F_2$
	F_1-5F_2	$2F_1-5F_2$	$3F_1-5F_2$	$4F_1-5F_2$	$5F_1-5F_2$

1. $F_{1M} = MF_1$
2. $F_{2N} = NF_2$
3. $P_{MN} = F_{1M} \pm F_{2N}$
4. RANGE OF M AND N IS FROM 1 TO INFINITY; PRACTICAL RANGE IS FROM 1 TO 10.

Fig. 7—This table shows the formation of mixing products by two input frequencies F_1 and F_2 and the first 5 *harmonics of each. Note that* 50 *separate products are formed here alone,* 25 *by the sums and* 25 *by the differences, although not all of these products are of different frequencies. The equations numbered* 1, 2, *and* 3 *define the table for all harmonics; m and n in these equations indicate the harmonics, while P_{mn} is the product pair for any specific harmonics. Whenever P_{mn} has the same frequency as some transmission of interest to someone else, that transmission suffers cross-modulation interference.*

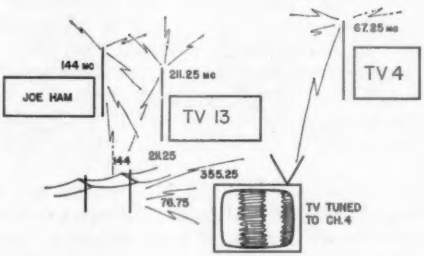


Fig. 8*—How cross-modulation causes interference. Joe Ham, operating a completely clean transmitter at* 144.0 *MHz, and TV Channel* 13, *also completely clean at* 211.25 *MHz (video carrier frequency) are on the air at the same time. Somewhere in the neighborhood, a corroded connection on a power-pole guy wire is acting as a non-linear element. Meanwhile, a TV viewer is trying to watch Channel* 4 *at* 67.25 *MHz, The* 144 *and* 211.25 *MHz signals mix to produce products all over the rf spectrum (only a few are shown). One of these is at* 67.25 *and interferes with the Channel* 4 *signal. If, however, Joe moves his frequency up ot* 144.1, *the interfering product will move down to* 67.15 *MHz and may no longer cause trouble.*

operating at anywhere near the frequency of the TV channel—the only requirement is that one of the products of the mixing come out on or near the TV station's frequency, and presto, instant TVI.

This form of TVI is quite difficult to isolate because it will go away whenever either of the two original signals goes off the air. You don't have to do a thing. If the other transmitter goes dead, the TVI ceases.

If the interferring product is formed by your fundamental, any modulation on your signal will be present on the product as well, making it quite easy for the TV viewer to obtain your call and work from there to lodge his complaints.

And the biggest problem about it is that you can do almost nothing to cure it. No malfunction of your transmitter is involved. No filtering, either at the transmitter or at the TV receiver, can stop it, since the interference is an actual radiated signal at the frequency of the desired channel and any filter which would remove it would remove the TV station as well.

The one sure cure is to change your operating frequency enough to move the offending product away from any TV channels. This doesn't actually cure the mixing, but it eliminates any interference to TV reception. Often a change of only a few kilocycles is adequate.

When cross-modulation is interfering with your own operation the picture is different. A classic case of this type of cross-modulation can be observed by any 2-meter operator who lives in an area served by television channels 4 and 13. The frequency separation between these two channels is exactly 144 MHz. When both stations are broadcasting, the DX portion of the band, from the bottom edge up to at least 144.05 MHz, becomes a howling mass of cross-modulated video, FM audio, and carriers.

The only cure for this problem is to avoid that part of the band, which is rather difficult if the stations you want to work stay there most of the time. Unlike ham stations, TV broadcasters are not free to change frequencies.

A cure which is sometimes effective is to locate and eliminate the offending nonlinear element. If you're lucky you may find it within a month or two—but keep in mind that a 1-watt signal can be heard for many miles. The re-radiated products are considerably weaker than one watt, but the cause of the crossmodulation may be anywhere within a two-to-three mile

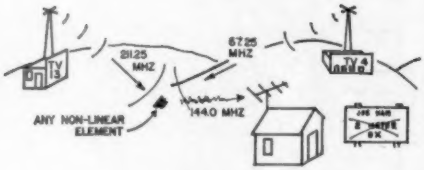


Fig. 9—It's not just the TV audience who get hurt by the problem of cross-modulation. Any two signals can do it, and one of the prime examples is that occurring when TV channels 4 and 13 operate in the same locality. 2-meter DX around 144.0 MHz is completely wiped out by the interference which results. Since any type of non-linear element can cause the mixing action, it's not normally practical to eliminate this problem; most of us just learn to live with it.

radius of your location. One such cause is all it takes, but there may be many. The odds are against you.

Cross-modulation is not limited to the "natural cause" case. It can also occur in the front end of your receiver, and frequently does. This type of cross-modulation can be cured readily by filtering out the offending signal. If the unwanted strong signals are too close to your desired signal (which is possible if you are getting a third-order product) for this to be practical, you may have to introduce an attenuator between antenna and receiver to cut back all signal strengths to the point that no overloading and resulting cross-modulation occurs. This cure is frequently used.

What Determines the Power Output of a Transmitter? Some amateur transmitters boast a power output of more than 2000 watts, legally. Others find favor with do-it-the-hard-way enthusiasts and radiate only a few milliwatts or even microwatts. Each type, as well as the wide spectrum between these limits, has its place.

But what determines the power output? No single answer to this question is possible, because power output is determined by many things. One of the most important factors is that of *what* power output we're talking about, since transmitters are rated by such various standards as average input power, average output power, peak input power, peak output power, peak envelope power (both input and output), and even indicated average input power!

Any attempt to compare various methods of transmission almost invariably comes a cropper over these differing types of rating power, and the FCC regulations themselves have a sort of built-in discrimination—which is, of all things, in favor of voice transmission and against CW!

The regulations, you see, limit the indicated input power to the stage or stages of the transmitter which supply rf power to the antenna. On the face of it this appears to be consistent for all modes of transmission.

Yet with FM, the indicated input power and the peak envelope input power are identical. The same is true with CW. High-level AM indicates only the carrier power; the additional power present in the sidebands which contributes to peak envelope power is not indicated. This means that with AM, a PEP input of 1500 watts is permitted if audio power is included. When SSB or DSB, with suppressed carrier, are employed, the indicators swing at a syllabic rate. In this case, the regulations state that the 1000-watt limit must never be exceeded by the indicators. They do recognize that the indicators cannot keep up with instantaneous peak levels, by specifying response times for the indicators of ¼ second maximum. This means that with SSB or DSB, PEP inputs of 2000 to 2500 watts are permissible just so long as the meters never read more than 1000 watts.

The same flickering effect is present when CW is transmitted, but the CW operator is denied the privilege of taking advantage of it. He must make his power measurements with key down; if he sets up for 1000 watts in this condition, his indicators won't exceed 750 watts in most cases. If he has a particularly choppy first, they may not exceed 600 watts.

In all these cases, "indicated average input power" is 1000 watts. The peak envelope powers, though, vary from 1000 watts up through something over 2000 watts depending upon the type of transmissions being generated. Transmission type, then, must be one of the factors determining peak envelope power's relation to indicated average input power.

It does not, however, affect the peak-power capability of an amplifier. The peak-power capabilities are determined by the characteristics of the tubes or transistors employed in the final stage or stages, by the supply voltage and the amount of current available rapidly (size of capacitors in power supply filter), and by the other design characteristics of the amplifier circuit.

Characteristics of the tubes or transistors in the final stage which determine a transmitter's peak-power capabilities are (1) the maximum current-handling ability of the cathode or emitter and (2) the permissable power dissipation or the plate or collector.

The maximum current-handling ability is not directly related to the rated maximum current. A cathode surface may be able to handle a full ampere for a sufficently brief period of time, yet be rated for only 50 to 100 mA maximum current. This comes about because the *rated* maximum current is a dc value and the tube is supposedly able to handle this amount of current for any period of time. The absolute maximum though, is set by point at which the cathode begins to physically disintegrate and is far greater. Tubes such as the 6C4, for instance, can deliver peak powers in the kilowatt range when operated under pulse conditions with sufficiently long time allowed for recovery between the extremely brief periods of active operation—but are hard put to deliver more than a watt or so in continuous operation.

The influence of the maximum current-handling ability is to set an upper limit on peak power. The tube cannot handle more current than it can; when you have all it can handle, you can't have any more.

The permissible power-dissipation for the tube determines peak-power capability by limiting the amount of *heat* which can be tolerated. This. in turn, is influenced by the type of amplifier involved. A Class A amplifier may turn ¾ of its dc input power into heat, while a Class C amplifier (using the same tube) might make heat from only ⅕ of its input.

Thus a tube capable of dissipating 10 watts would be able to run at an average power. input of only 13⅓ watts if operated Class A; 3⅓ watts power output would be produced, and the remaining 10 watts would be dissipated by the tube. The same tube, in Class C, could run at an average power input of 50 watts. Of these 50 watts, 40 would appear as output and the other 10 would heat up the transmitter.

Note that the power-dissipation limit applies to *average* power, not to peak. Heating and cooling take time, and anything that requires an appreciable period of time must involve only the *average* values over that period of time.

Note also that the effect of the power-dissipation factor is strongly dependent upon the operating conditions chosen for the amplifier—and these are included in those "other" design factors for the amplifier circuit.

The supply voltage and the amount of current rapidly available determine power capabilities, because power is simply the result of multiplying voltage times current. Voltage can be stepped up or down by means of transformers, but in any practical transmitter the voltage applied to the final amplifier stage at any instant rarely exceeds twice the voltage of the power supply, so this supply voltage is still a major factor.

Rapid availability of current is a factor not so widely recognized. In a power supply, though, whenever any current is taken out to produce rf power to be transmitted, that current must be restored through the rectifiers. The current taken out on an instantaneous power *peak* may be much greater than that which the rectifiers can supply, if there will be enough time before the next peak (while less current is being taken out) to make up the difference. The current ratings of the rectifiers, then, are not nearly so critical in determining transmitter power limits as is the amount of current *storage* within the supply. This means that filter capacitors on the output side of the supply should be as large in value as possible. It's difficult to have too much.

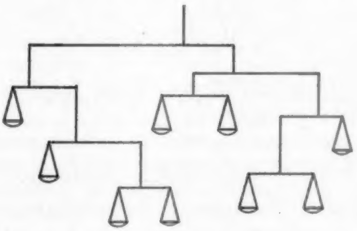


Fig. 10—Circuit factors affecting transmitter power are somewhat like the complicated set of scales shown here. Any change in any one factor will affect the balance of all other factors as well, but almost any combination of the various factors can be made to balance out with sufficient care.

Some of the other design factors which influence power capability include the choice to operate Class A, B, or C, discussed

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earlier; the type of coupling from amplifier tube to antenna and particularly the impedance level at which this coupling operates; and to a lesser degree the type of modulation employed.

With a given amount of dc voltage supplied and a given amount of current available, the power developed is determined directly by the load impedance across which the output signal is developed. The "Q" of the final tank circuit gets into the act since it determines the load impedance "seen" by the tube. For any useful power to be produced, the Q must be relatively low. A high-Q circuit may permit as much power to be developed at the tube as does a low-Q one, but the power cannot get out of the circuit if Q is high (by the definition of Q as the ratio of power stored during a cycle to power released during a cycle) and thus is of no use to you. At the same time, Q must be moderately high or the output circuit won't provide the desired tuning action. Choice of Q is always a compromise; the choice is normally made by the "loading" control of the transmitter. When loading is light, the Q is high; when loading is increased, the Q decreases.

Type of modulation to be used affects power in a number of subtle ways. Some of them were mentioned in the discussion of the various legal power limits. The "on-off" effect brought out there for SSB, DSB, and CW signals permits the factor of power dissipation to be modified by intelligent choice. For example, SSB and DSB signals have a very low *average* power in comparison to their peak-envelope-power levels. For this reason, when only such signals are to be transmitted tubes with very low power-dissipation ratings but very high peak-current capabilities may be chosen, and relatively great amounts of output power be developed. This is the reasoning behind the popularity of TV-output tubes as final amplifiers in the 100-400 watt range. The voltage and peak-current ratings of these tubes permit peak powers of 400 watts or more; power dissipation is low, but in DSB or SSB service the average power to be dissipated is also low and this factor becomes only a small restriction.

For FM service, or for CW, such tubes are pushing their limits at 100 watts or so. The only way in which even these power levels can be realized is to use the most efficient points available in Class C operation, to keep power dissipation within limits. Even so, it's not uncommon to literally melt down parts of the glass envelopes of such tubes in this application!

Next Month. One of the most important practical aspects of radio theory, though, is the making of measurements. Without measurements, you cannot operate. The importance of measurements can be judged by the fact that most of the FCC regulations require measurements of some type—and a major part of the examination deals with measurement techniques. That's our subject, next time. ■

License Plate Holder

One of the nicest little low cost items to turn up recently is a license plate holder which is being marketed by Ken Walkey WB6RSP. Most of the call letter license plates are the standard 6" x 12" and they really stand out when mounted in the Walkey holders. Across the bottom in blue letters on white background it tells the world that you are a radio amateur. The holders are triple chromium plated so they will not rust. They are $3.95 a pair from Ken Walkey, Box 3446, Granada Hills, California 91344.

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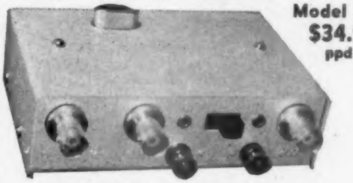

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Care and Feeding of a Ham Club—III

Carole Allen W5NQQ
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How About A Party?

Who needs help with a party, you ask? Sure, anybody can have one, but it takes planning if everyone is going to have fun, be it a ball, banquet, or barbecue.

The social side of radio clubbing means anything from coffee and cake after the business session to a full scale affair at a ritzy restaurant. Most hams like food, and there's no doubt that a bubbling percolator and sack of doughnuts adds to any evening. But these magic ingredients just don't appear out of the air—a committee will have to see that they do.

If meetings are held in members' homes, kitchens are handy, and many public meeting places also have facilities; however, yours may be a club that has to buy a hotplate or carry in goodies. Stag clubs are sometimes lucky enough to have Ladies' Auxiliaries who function with the purpose of planning refreshments for the fellows. A very satisfactory arrangement for many groups is taking turn-about at providing snacks. To prevent a last minute discovery that nobody is bringing the sugar bowl, it's a good idea to plan a social calendar in advance. If hosts and hostesses volunteer for meetings early in the year, a sheet can be printed and distributed showing who's going to serve and at what meeting.

In addition to regular get-togethers, most clubs sprinkle the year with picnics, barbecues, dances, card parties, and formal banquets. These events, and especially the last one, demand lots more work. Your choice of clambake will depend on your locale; for instance, the Pensacola (Florida) Amateur Radio Club gets a bang out of shrimp boils and fish fries, but a barbecue would probably be first choice in Southern California and a pot-luck buffet in Indiana.

Some wise soul once said that variety is the spice of life, and hams around the country prove it. The secret is not to be afraid to try anything once; if the card party is a flop, you won't repeat it; likewise, the party plan you had doubts about may really make a hit with the gang.

Hams like to laugh, and a party program is more successful with a few jokes. Bill, K9AKF, receives a mobile antenna complete with oil can and other awards from Program Chairman K9AMD.

Since all types of shin-digs require similar ground-work, let's see how one comparatively small group plans a whale of an annual spring whing-ding. The sponsoring club consists of about thirty active members and twenty not so active. Regular meetings are held monthly with both OMs and XYLs attending. Every April, members and their families hold a "Ham Scramble" at a community center where there is plenty of room and also kitchen facilities. Although the event is not designed on hamfest proportions, area hams are invited.

The Ham Scramble is held on Sunday and kicks off about 3 p.m. The afternoon is spent ragchewing and working on contests and paper games planned by special committees. QSL cards are displayed as well as surplus gear hauled in for swapping. Everybody mills around contentedly talking and "contesting" while the ladies prepare food and set tables. Each family brings its own table service and covered dishes for "scrambling." Coffee for hams and milk for harmonics is furnished.

"Chow time" is called about 5:30, and no one has to tell a ham what the word 'smorgasbord" means. A program following the meal begins with group singing and continues on the same informal note including the awarding of both serious and humorous prizes. This is a good time to award 100% attendance plaques or pins to deserving members as well as a "booby-type" prize to a ham who can take a joke. Ideas that have audiences rolling in the aisles include presenting a can of cleanser to someone who needs to clean up TVI, a megaphone for the fellow who has transmitter trouble or says he can't "get out," an ax or hatchet to cut QRM, a make-shift trophy for a new General Class operator, and other rib-tickling awards for hams who enjoy a good laugh.

The main event of the evening is planned to interest unlicensed wives and children also. An after-dinner speaker with stories for the kids, a colorful travelogue or entertaining film hits the spot with many groups.

If the winter-weather has been rough on the club's generator, a committee will need to step in and get it going before Field Day. Shown left to right: Al, K9OHJ; Burrell, K9JBZ; Dan, W9VEY; Dick, W9VWJ; and winding is Boyd, K9JFF.

A small club holding an annual "Ham Scramble" features contests for YLes and XYLs as well as the fellows. Trying to guess how many red-hot candies and buttons are in the jars are two "contesters." Watching are the chairman of the ladies game committee—(Right—Janean, W9BYQ; and second from right—Mary, K9WUA.)

One year an amateur magician kept everyone on the edges of their chairs.

After door prizes and awards for contest winners have been given, the party breaks up early enough that families will be home before the little people get too tired.

If a "Ham Scramble" appeals to your club, you'll be interested in the following list of committee chairmen who work together:

General Chairman and/or Co-Chairman
Registration
Publicity
Program
Dining Room and Decorations
Entertainment for Children
Contests
Exhibits
Prizes
Food
Kitchen and General Clean-Up

Some of these chairmen will also be needed if your club reserves a local restaurant once or twice a year for a banquet. A Reservations Chairman can handle ticket sales and deal with the Maitre D. Since parents usually hire babysitters for a banquet evening, the group will probably be adults and a dance or other entertainment can be planned to last into the late hours.

If you think you've got to have a reason for a party, don't overlook the Fourth of July, Halloween, Christmas, Valentine's Day and all of the wonderful holidays which offer lots of decoration and theme possibilities. A party during December will liven up the winter months when transmitter hunts

An annual dinner or party is a good chance to award amusing prizes or special honors for 100 per cent attendance during the year. The award recipients should, of course, know how to take a joke.

and outdoor activities are at a minimum. A family Christmas gathering may include a gift exchange set up with fun in mind. Hams can wrap radio components and keep them separated from toys brought by children for one another. Wives and girl friends should bring feminine type presents and put them in still another stack. With expenses at an all-year high at Christmas, perhaps a limit of $1.00 or less can be set on the exchange.

College campus clubs have problems of their own in party-planning such as time, location, money, and fresh ideas. The Michigan Tech Club of Houghton, Michigan, has a real gripe with 2200 fellows on campus, only 39 girls, and not a licensed YL among 'em. Unless the boys can find some girls for dances, record parties, or jazz fests, it looks like they'll have to be satisfied with something less. But an energetic gang of male hams should be able to organize some terrific transmitter hunts or spur-of-the-moment camping trips with portable gear. And if things get too gruesome, see what hams are doing in neighboring towns and pay up a school-term membership.

Admittedly, parties of all kinds require enthusiastic leadership, and when it spreads to the membership, any lack-of-interest problem will soon disappear. Chances are you'll find that your regular meetings as well as social gatherings will be lots more lively.

In the Good Old Summertime!

Shakespeare wrote about rare days in June, and hams talk about two in particular from one year to the next. The words "Field Day" mean alot of things to alot of people: Hams themselves regard this special weekend as not only a perfectly legitimate reason to skip lawn mowing and house-painting but a chance to see how emergency power and portable rigs work out under less than ideal conditions. A non-radio minded wife may look at Field Day as a pretty poor excuse for the OM to escape visiting her relatives; and Joe Brown, the dedicated television watcher on the other side of town, may sound off about "that bunch of clowns who stay up all night running the noisiest generator they can find!"

But aside from these different views, Field Day is, of course, the June weekend when hams answer the "call-of-the-wild" and set up stations in gullies and hills everywhere.

Field Day is for fun and also to test what your club can do when the chips are down. How quickly can a portable station be set up? Are the generators capable of carrying the load? Can operators endure wind, weather, and long hours behind the mike? All these questions should have some kind of answer when time runs out on Field Day and everyone collapses in a heap.

Your club may feel that lack of preparation adds to the reality of the Field Day operation, but, let's face it, if somebody doesn't do some "getting ready," it may be a lost weekend. For instance, if the commutator of the generator has developed a case of dirt and grime, it will take some pre-Field Day cleaning; and who can claim that an efficient antenna system can be set-up, tested, and put on the air in only a couple hours.

In other words, it's the old "Be Prepared" motto again. Committees appointed in the spring can have Field Day equipment

Club parties will depend on the locale. For instance, the Midwest group shown above really go for spring and fall wienie roasts: Left to right: Rosi, K9ESY; Naoma, K9MSY; Jane, mother of K9RHL; Carole, K9AMD, and Claire, K9TST.

The Fixed Station Committee will supervise the assembling of complete Field Day stations and that may mean a lot of elbow grease. Left—Dan, W9EZA, and Dick, W9VWJ, move a rig into place.

ship-shape before the end of June. That doesn't mean that operators aren't going to be tested on how well they perform over a long haul or that the equipment itself isn't going to face a work-out; it just means that drastic repairs and replacements won't have to be made when the beginning Count-Down is on.

The extent to which your club goes "all-out" will determine what committees will need to pitch in. If you're planning a caravan to a weedy lot, you'll want someone with a mower to visit it first, and maybe one of the members who like to camp out can move in with a large tent and facilities.

Big clubs with lots of mobile stations, portable rigs, generators and lots of operators can and do work out elaborate plans using everything and everybody available. But, big or small, clubs depend on committees and here's a list to stimulate your thinking:

General Field Day Chairman and/or Co-Chairman
Antenna Systems
Portable power plans (Preparation and Fuel)
Fixed Stations
Mobile Stations
Operators (The Personnel Man)
Rig Repairs
The Big Count-Up.

Although several of the above titles speak for themselves, let's elaborate on a couple. The Fixed Station Committee will direct the assembling of complete stations on the various bands and also coordinate a pattern of operation. If, for instance, the gang on 40 meters in the pup-tent decides to switch bands, they should know that the fellows in the tent next door are working on 20 phone and don't care for local QRM in addition to what's on the band. Tempers will stay cool if everyone knows who's operating where.

The Mobile Chairman's job is to know whose car will be available and at what times. Since most drivers have only two hands, a log keeper with sharp pencils should be sent with each car.

The Operators' Chairman will serve as the Personnel Man to compile a list of available members. First, who wants to do the actual operating? Do they prefer phone or key? What class licenses do these folks have? It isn't too good to assign a novice to run a kilowatt rig on 14.250. Not only names but times are vital statistics, for you've got to remember that Field Day is a 24 hour affair. Let the fellows and gals pick their own hours, and by looking over the list you'll be able to separate the night owls from the early birds. Next, prepare a 24 hour schedule using every licensed ham to the best advantage and assigning non-licensed enthusiasts to log-keeping posts. Better have some alternates in case of emergencies.

Most clubs have at least one ham who'd rather work on equipment than operate it, and he can save the day (or night) if he's around when a rig goes sour. If stand-by stations can be thrown into use while repairs are being made, all the better; if not, just hope your man Friday will make himself available during the whole weekend.

Hot, cold, or lukewarm coffee is a "must" for Field Day; and it's safe to say that some kind of a pot, percolator, or pan is on the fire at 99 per cent of Field Day locations from start to finish. OMes are noted for their ability to make coffee in any kind of container but they'll admit that the XYLes do a good job, too. And they'll also note that it's pretty nice to have the wife and kids show up to see what "Daddy's been doing all weekend." If the ladies want to pitch

Bobbi, K9GOL, at the right pours hot coffee on Field Day night for a group of tired operators. The gals who keep the coffee flowing are popular around any operating site.

in and really make Field Day a family event, pot-luck meals and picnics can be planned. An extra popular gal is the one who fries eggs and bacon at 6 a.m. Sunday morning when eyes are red and beards are bushy. Keeping the coffee coming from dusk 'til dawn puts the ladies at the top of the Hams' Hit Parade.

When time runs out along with energy, a big chore remains—the tremendous task of log checking and scoring. If someone skilled in deciphering Egyptian hierioglyphics doesn't volunteer, a committee will be needed to sort, count, correct, total, and cull out errors. After this gigantic job has been done, the lists are bundled up and sent to the American Radio Relay League, 38 La Salle Road, West Hartford, Connecticut. There's nothing left to do then but wait for the nationwide totals to be released in their magazine, *QST*, and try to think how next year's Field Day in the good old summertime can be made a little better.

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Other Contests

Field Day is by no means the one and only contest that your club can enter. Many clubs make an entire career out of the VHF contests. Some specialize in the VHF Sweepstakes in February, while others prefer to shoot for the September VHF Test. They sometimes go to rather great lengths in pursuing these contests.

Up Boston way hardly a VHF contest goes by without the Waltham, King Philip, or Rhododendron Swamp VHF Societies mustering of top of Pack Monadnock in New Hampshire or Mt. Greylock in northern Massachusetts for a king sized go. These fellows set up, even in mid-winter, with enormous beams on every VHF band, high power, and usually win the contest. Any group that hauls a 128 element two meter beam to the top of a mountain and sets it up on a tower deserves to win.

The Philmont Club leans more toward the DX Contests and just about every member is on there, hot a heavy, building up the club score. They use two meter intercoms, and the works. This contest runs in February and March every year.

In November we have the Sweepstakes Contest, another popular club effort. In October many clubs participate in the World Wide DX Contest.

All of these contests are good club projects. The members can work to help each other have their stations set up and also cooperate during the contests for the maximum number of contacts.

More next month.

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Payment of .... herewith (Postage Prepaid)

☐ Please Invoice on 10-day FREE Trial.

Name ....

Address ....

City .... State .... Zip..........

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MORE JOHNSON VARIABLES

# 152-516	Dual 470 pf/sec. 4500v. 5½" w, 5¾" h, 15" 1 + 1¼" for ¼" shafts. (8 LBS.) NEW............	4/$31.00	$8.50 ea.
# 160-110	2.7 to 19.6 pf, miniature. 3/16" slotted shaft	4/$3.25	79¢ ea.

BEST SELLERS, VERY LUCKY FINDS. LIMITED SUPPLY

RF Switch. CERAMIC.	2 deck, 5 position, 2 pole double break, 1 deck shorting, 1 deck non-shorting. 4" dia. 6" long + 1" for ¼" shaft. 1 KW+. (5 LBS). NEW..	4/$9.50	$2.50 ea.
85 KC IF	Late type Hi-Q, ceramic form. For R11A. NEW..	4/$4.75	$1.25 ea.
85 KC IF	Older type, bakelite form, for BC-453. NEW	4/$3.75	$1.00 ea.

More METERS.

0-5v DC	0-1 DC MA, basic movement, with internal 5000 ohm resistor. Black background, white figures. All clear, wide view plastic. Scales—0-10 ma; 0-500 ma; output 0-10. American made, for KNIGHT T-150. NEW	4/$10.00	$2.75 ea.
100 Ua DC.	1" square, Level meter, Basic 100 ua DC. JAP. Clear plastic. NEW	4/$5.50	$1.50 ea.
1 ma DC	2800 ohm internal resistance, 2" edgewise. JAP.	5/$9.75	$2.00 ea.

Hamfest Schedule—Findlay, Ohio, Sept. 8; Peoria, Ill., Sept. 15; Cincinnati, Ohio, Sept. 22.

All orders, except in emergency, or I'm at a hamfest, shipped same day received. For free "GOODIE" sheet, send self-addressed, stamped envelope—PLEASE, PLEASE include sufficient for postage, any excess returned with order. I carry private (Travelers) parcel post insurance, for domestic parcel post. For items too heavy, or too large for parcel post, I suggest bus parcel express. Please advise name of bus line, and city, where you can pick up the shipment.

Canadian customers—PLEASE add sufficient for postage—$1.00 first two pounds, 30c each additional pound or fraction.

B C Electronics

Telephone 312 CAlumet 5-2235
2333 S. Michigan Avenue Chicago, Illinois 60616

COMPUTER GRADE CAPS

4,000 mfd at 50 volt ....**$1.00 each, 12 for $10.00**
6,500 mfd at 18 volt ....**$1.00 each, 12 for $10.00**

60 WATT TRANSISTORS 80 VOLTS

From computer assemblies, board with 4 each power transistors 2N1137B, 60 watt, 80 volt PNP power ....**$1.25 per board**

SUPER VALUE $2.50

Computer boards with 8 each 2N1137B power transistors & mounting hardware, also include on the board, 4 each 10 volt zeners, 4 silicon diodes 1 amp 800 volt PIV, computer grade cap 2000 mfd 65 volt Bourns trimpots, precision resistors, etc. Complete assembly like new ....Ship wgt. 3 lb. **$2.50**

RF FILTER

From HAWK MISSILE termination contract. Good for 5 amps, 600 volt, 10 cycles to 500 mc, insertion loss 60 DB-plus, low pass pi-network type, excellent as feed-thru filter in converters, transmitters. Hermetically sealed inside are 2 toroidal chokes & 4 low induct. caps. #41102 ....**$1.00 each, 6 for $5.00**

PISTON CAPS

Corning glass, direct traverse type, min. Q at max. C—500 at 50MC. 500 volt breakdown. Capacitance range 1-8 uufd. Brand new military surplus ....**3 for $1.00 or $3.00 per dozen**

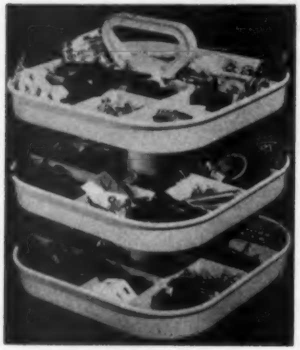
We have a catalog . . . if you send 25c for it, you'll get it someday.

All material FOB Lynn, Mass.
Which means, send postage.

JOHN MESHNA, JR.

PO Box 62 E. Lynn Mass. 01904

IS THIS BRIBERY?



$5 PARTS BIN

← **FREE**

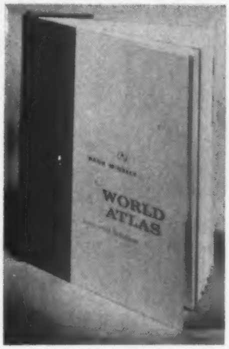
With 1 New $6 Subscription!

This three-tiered parts holder is just the thing for the workshop. The three shelves revolve to put parts right at your hand. Stop searching for things.

FREE →

With 2 New $6 Subscriptions!

The famous Rand-McNally Imperial world atlas. Over 300 pages, handsomely bound. For the ham shack, for the family, for the student. Maps, people, political information, historical gazetter, facts. Makes working DX twice the fun.



$13 WORLD ATLAS

HOW COME? We added up the cost of soliciting new subscribers through the mail: mailing lists, brochures (paper, artwork, typesetting, printing, folding, delivery), envelopes (plus printing and shipping) for the brochures, return envelopes, putting brochures together, addressing, bundling by zip, plus postage. Multiply that by ten to account for the one in ten response and add the return postage. We decided to put all that money into premiums and give them to readers that sell new subscriptions to their friends and fellow club members. It seemed worth a try.

$10 V-O-M

← **FREE**

With 3 New $6 Subscriptions

20,000 ohms per volt V-O-M. Ohms: 1K, 10K, 100, 1M; Volts dc: 2.5, 10, 50, 250, 500, 5000; volts ac: 10, 50, 250, 500, 1000; dc mA: .05, 5, 50, 500; db: 0, 14, 28, 34, 40. Invaluable around any hamshack or workshop.

FREE →

With 4 New $6 Subscriptions!

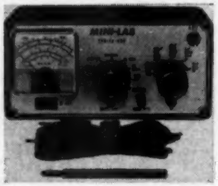
Hammond 18" International World Globe. This not only makes DXing more fun, it is of value to the whole family. No child should grow up in a household without a good world globe. You can use charts if you like for swinging your beam, but a globe is better.

$17 HAMMOND GLOBE

HERE'S THE DEAL. These premiums are for getting new subscribers for 73, not renewals. You, knowing 73 as you do, can sell it a lot better than one of our mailing pieces. You won't get lost in the daily deluge of mail solicitations and the credibility gap that they have wrought. You know what's good about 73 and what's bad. You know that you will be doing your friends a favor if you get them to subscribe because you will be making ham radio a lot more fun for them. Our hobby is much better when you keep up to date on technical and political developments. Send in the subscriptions with $6 for each new one year sub, each on a separate 3 x 5 card with name, call, address and zip code, and add one card with your name and address and the prize you desire. Not bad for doing a few friends a favor! This offer is good in the USA and APO only. Offer expires Aug. 31, 1968. All subs will start with the October issue.

THEY WOULDN'T DARE!

PRIZES FOR SUBSCRIPTIONS

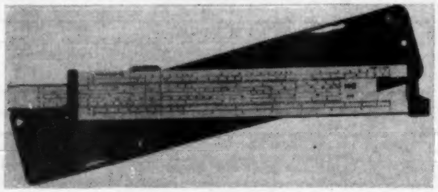


$25 TEN-IN-ONE MINILAB FREE WITH 5 NEW $6 SUBSCRIPTIONS

Volts ac & dc: 15, 50, 150, 500; Ohms: 10K, 100K, 1M; mA: 500; resistance substitution: 100, 1K, 10K, 100K, 1M; Capacitance substitution: .002, .005, .02, .1, 10uF; RF field strength; 9V battery supply; RF signal generator at 455 kHz to 700 kHz; AF generator at 400 Hz. Comes with test leads, antenna and battery. Invaluable for mobile servicing or around the shack.

$12 BLANKET FREE WITH 2 NEW $6 SUBSCRIPTIONS

This 50" x 60" sport blanket comes from Spain and is made of virgin wool, cotton and rayon. Machine washable. Beautiful yellow red and black design. Comes in zipper vinyl case with handle. Fine for the car, picnics, etc.



$3 K & E SLIDE RULE FREE WITH 1 NEW $6 SUBSCRIPTION!

A slide rule is indespensible around the ham shack or the office. This one has everything you need, but is inexpensive enough so you can get two or three. Has C, D, A, B, S, T, Cl, L, and K scales. Comes complete with case. 10" long with indented green ruling.

BIG SWINGER

$25 NEW BIG SWINGER FREE WITH 7 NEW $6 SUBSCRIPTIONS

The New Big Swinger Polaroid camera uses the regular black and white film packs, making the large 3¼x4¼" pictures. Drop flashbulb into camera. Built in photometer. No focusing two feet to infinity. Why miss out on Polaroid fun any longer?

24 HOUR OPERATING DESK CLOCK FREE WITH 5 NEW $6 SUBSCRIPTIONS!

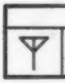
This beautiful clock has numbers you can really see. Keep it right in front of the rig and set up with GMT time so you can keep the log correctly. The numbers go up to 24 hours. This desk clock normally sells for $25.

These premiums are offered for groups of new subscriptions to 73. USA or APO only. Send each new subscribers name, call, address and zip on a separate 3 x 5 sheet of paper. Subscriptions take about six weeks to process. On a separate sheet give your name, call, address and zip and the premium you want. Please allow eight weeks for delivery just in case the demand is heavy and we have to wait for factory delivery. We'll try to make immediate delivery when possible. This offer expires July 31st and all subs must be postmarked before that date. Send $5 for each new sub.

73 MAGAZINE **PETERBOROUGH, N.H. 03458**

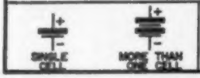
ELECTRONIC SYMBOLS

ANTENNA



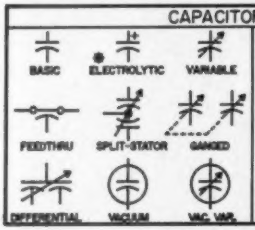
NORMALLY USED IN BLOCK DIAGRAMS, BUT MAY BE USED IN ANY SCHEMATIC WHERE ANTENNA IS CONNECTED DIRECTLY TO CIRCUIT WITHOUT BENEFIT OF RF CONNECTOR

BATTERY


+
−
SINGLE CELL
+
−
MORE THAN ONE CELL

DO NOT FORGET TO INDICATE VOLTAGE AND POLARITY

CAPACITORS


BASIC
+
✱ ELECTROLYTIC
VARIABLE
FEEDTHRU
SPLIT-STATOR
GANGED
DIFFERENTIAL
VACUUM
VAC. VAR.

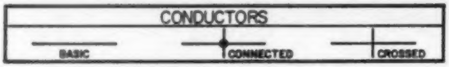
NOTE THAT CURVED PORTION OF SYMBOL ALWAYS DESIGNATES OUTSIDE FOIL OF FIXED CAPACITORS (EXCEPT ELECTROLYTICS, WHERE IT INDICATES THE NEGATIVE TERMINAL)

THE CURVED PORTION IN THE CASE OF A VARIABLE WILL INDICATE THE MOVABLE PART

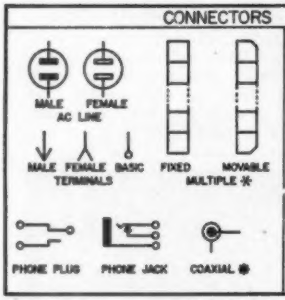
✱ INDICATE POLARITY, AND VALUE IN μF

WHEN OTHER THAN ELECTROLYTIC, VALUES ARE ASSUMED TO BE pF WHEN 1 OR GREATER, AND μF WHEN LESS THAN 1

CONDUCTORS


BASIC
CONNECTED
CROSSED

CONNECTORS

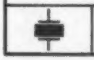

MALE
FEMALE
AC LINE
MALE
FEMALE
BASIC
TERMINALS
FIXED
MOVABLE
MULTIPLE *
PHONE PLUG
PHONE JACK
COAXIAL ✱

SHOULD NONE OF THE SYMBOLS DESCRIBED HERE SEEM TO MATCH YOUR SITUATION, DESCRIBE THE CONNECTOR AND/OR LIST THE MANUFACTURER'S PART NUMBER

✱ FOR ANY COAXIAL-TYPE CONNECTOR, SUCH AS RF, MICROPHONE, PHONO, ETC.

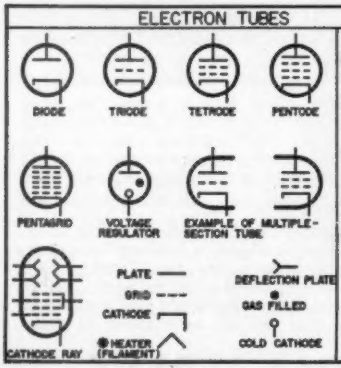
* NUMBER THE BLOCKS TO CORRESPOND TO TERMINAL MARKINGS, WHEN APPROPRIATE

CRYSTAL



ALWAYS INDICATE CRYSTAL FREQUENCY (IN kHz, MHz, ETC.)

ELECTRON TUBES

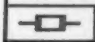

DIODE
TRIODE
TETRODE
PENTODE
PENTAGRID
VOLTAGE REGULATOR
EXAMPLE OF MULTIPLE-SECTION TUBE
CATHODE RAY
PLATE
GRID
CATHODE
✱ HEATER (FILAMENT)
DEFLECTION PLATE
GAS FILLED
COLD CATHODE

ALWAYS LABEL ELEMENTS WITH TUBE PIN NUMBERS

REFER TO TUBE MANUAL FOR DATA ON INDIVIDUAL TUBE TYPES

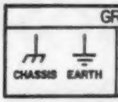
✱ FILAMENTS OR HEATERS (WITH THE EXCEPTION OF DIRECTLY-HEATED CATHODES) SHOULD BE SHOWN EXTERNAL TO TUBE CIRCLE, AND PREFERABLY IN THE POWER SUPPLY

FUSE



INDICATE CURRENT, VOLTAGE RATINGS, AND SLO-BLO, ETC., AS APPROPRIATE

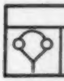
GROUND CONNECTIONS


CHASSIS
EARTH

CHASSIS GROUND SYMBOL IS NORMALLY THE ONLY TYPE USED IN SCHEMATICS

EACH GROUNDED CIRCUIT COMPONENT WILL BE SHOWN CONNECTED TO AN *INDIVIDUAL* CHASSIS GROUND, UNLESS A COMMON GROUND BUS IS ESSENTIAL TO PROPER CIRCUIT OPERATION

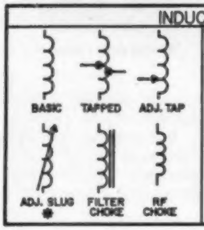
HEADSET



NORMALLY USED IN BLOCK DIAGRAMS, BUT MAY BE USED IN ANY SCHEMATIC WHERE CONNECTED DIRECTLY INTO CIRCUIT WITHOUT PHONE PLUG

INDICATE IMPEDANCE IF VALUE IS CRITICAL

INDUCTORS

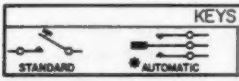

BASIC
TAPPED
ADJ. TAP
ADJ. SLUG ✱
FILTER CHOKE
RF CHOKE

INCLUDE ALL NECESSARY DATA INCLUDING ANY OF FOLLOWING INFORMATION WHICH IS APPLICABLE:

- WIRE SIZE & TYPE
- COIL OR FORM O.D. OR I.D.
- NUMBER OF TURNS AND/OR LENGTH
- MANUFACTURERS PART NUMBER
- TAP POSITION ABOVE COLD END

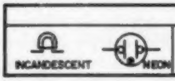
✱ FERRITE CORE WILL BE ASSUMED UNLESS BRASS IS SPECIFIED. INDICATE TYPE OF FERRITE, IF CRITICAL

KEYS


STANDARD
✱ AUTOMATIC

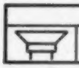
✱ BE SURE TO DESIGNATE "DIT" & "DAH" CONTACTS

LAMPS


INCANDESCENT
NEON

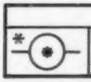
INDICATE MANUFACTURER'S PART NUMBER AND/OR VOLTAGE & CURRENT RATING

LOUDSPEAKER



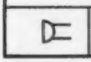
INDICATE VOICE COIL IMPEDANCE & POWER RATING, ETC., WHEN CRITICAL

METERS



✱ INDICATE TYPE OF METER HERE (μA, mA, V, ETC.)
* INDICATE SCALE RANGE HERE (0-1, 0-50, ETC.)
DON'T FORGET TO INDICATE PROPER POLARITY

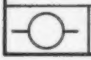
MICROPHONE



NORMALLY USED IN BLOCK DIAGRAMS BUT MAY BE USED IN SCHEMATIC WHEN WIRED DIRECTLY INTO CIRCUIT WITHOUT CONNECTOR

INDICATE TYPE (CARBON, XTAL, ETC.)

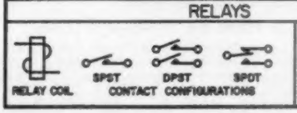
MOTOR



LABEL AS MOTOR, FAN MOTOR, ETC.

INDICATE OPERATING VOLTAGE & CURRENT AND/OR MANUFACTURER'S PART NUMBER

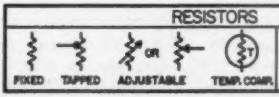
RELAYS


RELAY COIL
SPST
DPST
SPDT
CONTACT CONFIGURATIONS

SPECIFY COIL VOLTAGE, RESISTANCE, ETC., AND/OR MANUFACTURER'S PART NUMBER

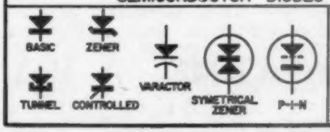
CONTACT CONFIGURATIONS SHOWN ARE BASIC AND MAY BE EXPANDED

RESISTORS


OR
T
FIXED
TAPPED
ADJUSTABLE
TEMP. COMP.

INDICATE VALUE, IN OHMS (Ω), KILOHMS (k), OR MEGOHMS (M), AND/OR MANUFACTURER'S PART NUMBER.
1/2 W 10% IS ASSUMED UNLESS OTHERWISE NOTED

SEMICONDUCTOR DIODES

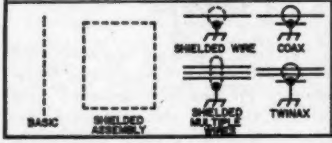

BASIC
ZENER
TUNNEL
CONTROLLED
VARACTOR
SYMETRICAL ZENER
P-I-N

INDICATE MANUFACTURER'S PART NUMBER AND/OR APPROPRIATE RATINGS

REFER TO MANUALS FOR SYMBOLS NOT SHOWN

ELECTRONIC SYMBOLS

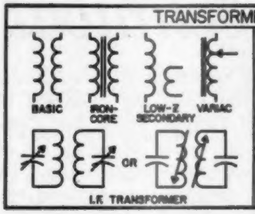
SHIELDING



SHIELDS ARE ASSUMED TO BE GROUNDED UNLESS OTHERWISE NOTED

INDICATE IF SHIELD ON CONDUCTOR IS TO BE GROUNDED ONE END ONLY, & SPECIFY WHICH END

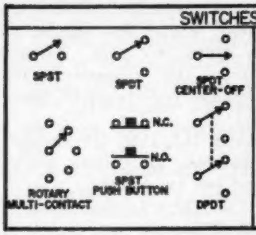
TRANSFORMERS



SHOW (4) LOOPS EACH WINDING EXCEPT (6) LOOPS ON HIGH-VOLTAGE SECONDARIES AND (2) ON FILAMENT WINDINGS AND NON-RESONANT LOW-Z RF COUPLING LINKS

TRANSFORMER DESCRIPTION SHOULD INCLUDE MANUFACTURER'S PART NUMBER AND RATINGS, OR CONSTRUCTION DATA

SWITCHES



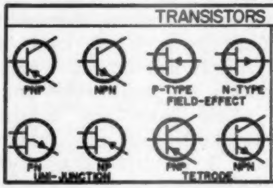
ONLY BASIC CONFIGURATIONS ARE SHOWN. COMBINE OR EXPAND AS NECESSARY TO SUIT

SELF-HOLDING SWITCH OPERATION IS ASSUMED UNLESS SPRING-RETURN IS SPECIFIED

NON-SHORTING TYPE IS ASSUMED UNLESS SHORTING TYPE IS SPECIFIED

SWITCH SECTIONS WHICH ARE SIMULTANEOUSLY OPERATED OR GANGED SHOULD BE JOINED WITH A DOTTED LINE

TRANSISTORS



SPECIFY MANUFACTURER'S PART NUMBER OR RATINGS

REFER TO TRANSISTOR MANUALS FOR TYPES NOT SHOWN HERE.

ELECTRONIC ABBREVIATIONS

(AS USED ON DRAWINGS AND SCHEMATICS)

NOMENCLATURE	ABBREVIATION(S)
ALTERNATING CURRENT	AC
AMPERE	A
AMPLIFIER	AMP
AMPLITUDE MODULATION	AM
ANTENNA	ANT
AUDIO FREQUENCY	AF
AUTOMATIC FREQUENCY CONTROL	AFC
AUTOMATIC GAIN CONTROL	AGC
AUTOMATIC VOLUME CONTROL	AVC
BATTERY	B
BEAT FREQUENCY OSCILLATOR	BFO
BROADCAST	BC
CAPACITANCE, CAPACITOR	C
CONTINUOUS WAVE	CW
CRYSTAL	X, XTAL
CURRENT	I
DECIBEL	dB
DIODE, SEMICONDUCTOR (ALL TYPES)	D
DIRECT CURRENT	DC
DOUBLE COTTON COVERED	D.C.C.
DOUBLE POLE DOUBLE THROW	DPDT
DOUBLE POLE SINGLE THROW	DPST
DOUBLE SILK COVERED	D.S.C.
ELECTRON TUBE (ALL TYPES)	V
ENAMEL COVERED	ENAM
FILAMENT	FIL
FREQUENCY	FREQ, f
FREQUENCY MODULATION	FM
FUSE	F
GROUND	GND
HENRY	H
HERTZ (CYCLES PER SECOND)	Hz
IMPEDANCE	Z
INDUCTANCE, INDUCTOR	L
INSIDE DIAMETER	I.D.
INTERMEDIATE FREQUENCY	I.F.
JACK	J
KILOHERTZ (KILOCYCLES PER SECOND)	kHz
KILOHM	k, kΩ
KILOVOLT	kV
KILOWATT	kW
LAMP	I
LOUDSPEAKER	SPKR
MEGAHERTZ (MEGACYCLES PER SECOND)	MHz
MEGOHM	M, MΩ
METER	M
MICROAMPERE	µA
MICROFARAD	µF
MICROHENRY	µH
MICROPHONE	MIC
MICROVOLT	µV
MICROWATT	µW
MILLIAMPERE	mA
MILLIHENRY	mH
MILLIVOLT	mV
MILLIWATT	mW
NEGATIVE (POLARITY)	−, NEG
NORMALLY CLOSED	NC
NORMALLY OPEN	NO
OHM	Ω
OSCILLATOR	OSC
OUTSIDE DIAMETER	O.D.
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PLUG	P
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RECEIVER	RCVR
RELAY	K
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VERY HIGH FREQUENCY	VHF
VOLT OHM METER	VOM
VOLT, VOLTS	V
VOLTAGE	E
WATT	W
WAVELENGTH	λ

Technical Aid Group

Please refer any questions of a technical nature to one of the following members of 73's Technical Aid Group. These are dedicated amateurs who really want to be of help and do so without compensation. Be sure to state your problem clearly and enclose a S.A.S.E. for a reply. I recently got a request from a reader asking me what to do about mobile noise. What kind of noise? He didn't specify any details. I gave him a general answer and made some suggestions, but it would have been helpful if he had described the kind of noise, under what circumstances it occurred, and what he had already done to try to eliminate the problem. Be specific about what you want. We are not mind readers.

John Allen, K1FWF, high school student, 51 Pine Plain Road, Wellesley, Mass. 02181. HF and VHF antennas, VHF transmitters and converters, AM, SSB, product data, and surplus.

Bert Littlehale, WA1FXS, 47 Cranston Drive, Groton, Conn. 06340. Novice transceivers, test equipment and homebrew projects gone wrong.

Bob Groh WA2CKY, BSEE, 123 Anthony Street, Rochester, New York 14619. Specializes in VHF/UHF solid-state power amplifiers, but will be glad to make comments on any subject.

G. H. Krauss, WA2GFP, BSEE, MSEE, 70-15 175 Street, Flushing, New York 11365. Will answer any questions, dc to microwave, state-of-the-art in all areas of communications circuit design, analysis and use. Offers help in TV, AM, SSB, novice transmitter and receivers, VHF antennas and converters, receivers, semiconductors, test equipment, digital techniques and product data.

Charles Marvin W8WEM, 3112 Lastmer Road, RFD #1, Rock Creek, Ohio 44084. Will help with any general amateur problems.

Stix Borok WB2PFY, high school student, 209-25 18 Avenue, Bayside, New York 11360. Novice help.

Clyde Washburn K2SZC, 1170 Genesee Street, Building 3, Rochester, New York 14611, TV, AM, SSB, receivers, VHF converters semiconductors, test, general, product data.

Richard Tashner WB2TCC, high school student, 163-34 21 Road, Whitestone, New York 11357. General.

J. J. Marold WB2TTZK, OI Division, USS Mansfield DD278, FPO San Francisco, California 96601. General.

Ira Kavaler, WA2ZIR, BSEE, 671 East 78 Street, Brooklyn, New York 11236. SSB transmitting, color TV, computer programming and systems, digital, radio and remote control, rf transmission lines, dipole design, audio amplifiers, linear and class C rf amplifiers.

Fred Moore, W3WZU, broadcast engineer, 4357 Buckfield Terrace, Trevose, Pa. 19047. Novice transmitters and receivers, HF and VHF antennas, VHF converters, receivers, AM, SSB, semiconductors, mobile test equipment, general, product data, pulse techniques, radio astronomy, bio-medical electronics.

Walter Simciak, W4HXP, BSEE, 1307 Baltimore Drive, Orlando, Florida 32810. AM, SSB, Novice transmitters and receivers, VHF converters, receivers, semiconductors, mobile, test-equipment, general.

James Venable K4YZE MS, LLB, LLM, 119 Yancey Drive, Marietta, Georgia. AM, SSB, novice gear, VHF, semiconductors, and test equipment.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont Street, Falls Church, Virginia 22042 General.

Wayne Malone W4SRR BSEE, 8624 Sylvan Drive, Melbourne, Florida 32901. General.

Bruce Creighton WA5JVL, 8704 Belfast Street, New Orleans, Louisiana 70118. Novice help and general questions.

Douglas Jensen, W5OG/K4DAD, BA/BS, 706 Hwy 3 South, League City, Texas 77573. Digital techniques, digital and linear IC's and their applications.

Louis Frenzel W5TOM, BAS, 4822 Woodmont, Houston, Texas 77045. Electronic keyers, digital electronics, IC's commercial equipment and modifications, novice problems, filters and selectivity, audio.

George Daughters WB6AIG, BS, MS, 1613 Notre Dame Drive, Mountain View, California. Semiconductors, VHF converters, test equipment, general.

Glen H. Chapin, W6GBL, 3701 Trieste Drive, Carlsbad, Calif. 92008. HF and VHF antennas, novice transmitters and receivers, VHF converters, semiconductors, receivers AM, SSB, general, surplus.

Tom O'Hara W6ORG, 10253 East Nadine Temple City, California 91780. ATV, VHF converters, semiconductors, general questions.

Steve Diamond WB6UOV, college student, Post Office Box 1684, Oakland, California 94604. Repeaters and problems regarding legality of control methods. Also TV, novice transmitters and receivers, VHF antennas and converters, receivers, semiconductors, and product data.

Orris Grefsheim WA6UYD, 1427 West Park, Lodi, California 95240. TV, HF antennas, SSB, VHF antennas and converters receivers, semiconductors, and general questions.

Hugh Wells, W6WTU, BA, MA 1411 18th Street, Manhattan Beach, Calif. 90266. AM FM receivers, mobile test equipment, surplus, amateur repeaters, general.

Carl Miller WA6ZHT, 621 St. Francis Drive, Petaluma, Calif. 94952. Double sideband.

Howard Pyle W7OE, 3434—7th Avenue, S.E., Mercer Island, Washington 98040. Novice help.

PFC Grady Sexton Jr. RA11461755, WA1GTT/DL4, Hedmstedt Spt. Detachment, APO New York 09742. Help with current military gear, information from government Technical Manuals.

Sgt. Michael Hoff WA8TLX, Box 571, 6937th Comm. Gp., APO New York 09665. Help with all types of RTTY both commercial and military. Also data techniques. Covers conversion of military RTTY equipment.

Eduardo Noguera M. HK1NL, EE. RE, Post Office Box Aereo 774, Barranquilla, Columbia, South America, Antennas, transmission lines, past experience in tropical radio communications and maintenance, HF antennas, AM, transmitters and receivers, VHF antennas, test equipment and general amateur problems. Can answer questions in Spanish or English.

D. E. Hausman, VE3BUE, 54 Walter Street, Kitchener, Ontario, Canada. Would like primarily to help Canadians get their licenses. Would be able to help with Novice transmitters and receivers.

Frank M. Dick WA9JWL, 409 Chester St., Anderson, Indiana 46012. Will answer queries on RTTY, HF antennas, VHF antennas, VHF converters, semiconductors, mobile, general, and microwave.

Gary De Palma, WA2GCV/9, P.O. Box 1205, Evanston, Ill., 60204. Help with AM, Novice transmitters and receivers, VHF converters, semiconductors, test equipment, digital techniques and all general ham questions.

Arthur J. Prutzman K3DTL, 31 Maplewood, Dallas, Pennsylvania 18612. All phases of ham radio. Can assist with procurement of parts, diagrams, etc.

William G. Welsh W6DDB, 2814 Empire Ave., Burbank, Calif. 91504. Club licensing classes and Novice problems.

Ralph J. Irace, Jr., WA1GEK, 4 Fox Ridge Lane, Avon, Conn. 06001. Help with Novice transmitters and receivers and novice theory.

Iota Tau Kappa Radio Fraternity W7YG, Multnomah College, 1022 S.W. Salmon St., Portland. Oregon 92705. This group of radio amateurs will answer any technical questions in the field of electronics.

Ted Cohen W4UMF, BS, MS, PhD. 6631 Wakefield Drive, Apt. 708, Alexandria, Va. 22307. Amateur TV, both conventional and slow scan.

Roger Taylor K9ALD, BSEE, 2811 West Williams, Champaign, Illinois 61820. Antennas, transistors, general.

Michael Burns Jr. K9KOI, 700 East Virginia Avenue, Peoria, Illinois 61603. AM, SSB, receivers, transmitters, digital techniques, novice help, general.

Jim Jindrick WA9QYC, 801 Florence Avenue, Racine, Wisconsin 53402. Novice transmitters and receivers, general.

John Perhay WA0DGW/WA0RVE, RR #4 Owatonna, Minnesota 55060. AM, SSB, novice transmitters and receivers, HF receivers, VHF converters, semiconductors, mobile, product data, general. Has access to full specifications on almost all standard components presently catalogued by American manufacturers.

Ronald King K8OEY, Box 227, APO New York, New York 09240. AM, SSB, novice transmitters and receivers, HF receivers, RTTY, TV, test equipment, general.

Charlie Marnin W8WEM, 3112 Latimer Road, RFD 1, Rock Creek, Ohio 44084. General technical questions.

Michael Winter DJ4GA/W8, MSEE, 718 Plum Street, Miamisburg, Ohio 45342. HF antennas, AM, SSB, novice gear, semiconductors.

David D. Felt, WA0EYE, television engineer, 4406 Center Street, Omaha, Nebraska 68105. Integrated circuits, transistors. SCR's, audio and rf amplifiers, test equipment, television, AM, SSB, digital techniques, product data, surplus, general.

Tom Goez K0GFM, Hq Co USAMAC, Avionics Division, APO New York, New York 09028. HF antennas, mobile, airborne communications equipment, particularly Collins and Bendix gear, AM, FM, or SSB—HF, VHF, UHF, general.

Robert Scott, 3147 East Road, Grand Junction, Colorado 81501. Basic electronics, measurements. ■

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local and state police. Talk with your local newspaper and radio or television station. Put the word out through the CB group. It is a good idea to canvas all other users of mobile radio in your area too so that if anything is reported by any of them the word will be passed along immediately to you. This could be any doctors with mobile radio, power company trucks, road crews, delivery trucks, taxis, the telephone company, etc.

Our net is tied in with NICAP, the most energetic organization in the country investigating the UFO reports. Net members and net controls will be expected to get in touch with their local NICAP investigating groups so they can coordinate with our net. Your local NICAP man may have an interesting UFO slide show that can be put on for your club. You might drop a line to NICAP, 1536 Connecticut Ave., Washington DC 20036. Membership is $5 and well worth while.

Even without any on the air alerts, the mere establishing of our net will provide both a useful service for any types of emergencies and a medium for excellent public relations for amateur radio . . . which we can definitely use. Try and get your local paper to do an article about your participation in the net. Perhaps you can get interviewed on the radio station. Talk about amateur radio.

NICAP reports that sightings have been way down for the last few months. Perhaps the UFO people are boycotting us in protest over the University debacle? Or are they worried over our UFO reporting net? Come on out, UFO's, let's see you. I do hope I am sitting by with a tape recorder when the net gets its first UFO report. That will be a historic bit of pandemonium to have on tape. I keep one of those little cassette recorders by the rig now at all times . . . never know when something interesting might happen.

I would particularly like to thank Chuck, W5GDQ (Dallas) for his net control work with the UFO net, right from the beginning. Chuck has only missed one net control so far, and that was when he was out of town.

Auto-Call Wanted

As our net grows more and more operators will be wanting to be able to be alerted whenever something is reported anywhere in the country. Few of us are going to just leave the receiver tuned into the frequency waiting for that call. What we need is a fairly fool-proof calling system. I should think that some sort of tone system . . . or perhaps two tones might work. There are some fairly sophisticated filters available these days. We are open for articles along this line.

Slow Scan Television

The FCC apparently has finally come through with the slow scan tv permission. We'll have the exact frequency allocations by and by. This rule change has been hanging fire for about seven years now. Opponents to the proposal grumble that the slow scan signals are horribly wide and make a mess in the phone bands. Proponents point out all the things we can do with slow scan. We shall see more of both sides.

We have a couple of slow scan articles in the works here and will publish them as soon as we can. We are interested in more. Andre of Vanguard Labs has an idea that you might like to play around with . . . he is working on a system that will use a regular tv camera and monitor. Then you would record the signal on a drum and slow down the drum for radio transmission. The signals would record on another drum at the other end and this would speed up and the picture could be seen on the monitor. Instead of using a slow phosphor viewing tube you would just repeat the same picture over and over.

At any rate, slow scan is here so let's see what we can do with it. Let's try to cause as little QRM with the signals as we can and see what kind of interesting systems we can work out. It wasn't very many years ago that there were a lot of laughs when I proposed a WAS certificate for RTTY. Now it is time for one for television!

Your Advanced Class License

Our series on the Advanced License Study Course is winding up this fall. If you've followed the series you should have no trouble at all in getting your ticket and keeping most of your allocations. We will continue on with a study guide for the Extra Class and, I suspect, eventually go back and provide you with a course for the General Ticket.

Many of our readers write to tell us that the course is being used with great effectiveness by their clubs, with an hour or so devoted to questions and answers at the beginning of each club meeting based upon the current text. When the series is done we will bring the whole thing out in a separate book which can be kept at hand for future club courses. . . . Wayne

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WTW Report

Since the last report, conventions and hamfests have caused QRM and we missed the last issue of the magazine. We now have a good system lined up, so my service to all of you will be speedier and more efficient. Remember . . . send all reports directly to me. Don't send anything to 73 Magazine. I have all the certificates here and am sending them directly.

We still need a good club in W/K1, W/K2, and W/K0, as well as Africa for WTW card check points.

There seems to be some confusion about phone certificates. SSB and AM are both phone, and count toward the award for either mode.

Regarding Don Miller's cards . . . we are only accepting the ones that ARRL accepts toward DXCC, thus no one can say we make our rules as we go along. We accept as a country any spot recognized by any national radio society. If ARRL accepts, we do too. If RSGB accepts it we do too, Send 25¢ to get a copy of the country list/tally sheet. This will relieve any doubts you might have.

There are strong rumors that a number of fellows are getting close to WTW-300 on 20 now. I wonder who will be first to qualify? Check your cards very carefully as we look them over with a critical eye and will disqualify any which show they have been tampered with.

To make the task of anyone checking your cards for the awards easier, I strongly suggest, when possible, to have all QSO information on one side of the card, along with your call sign in fairly large letters. Next time you have QSLs printed, how about keeping this in mind? The business of flipping cards over and over when checking them can become a chore and requires twice the time.

Remember, to qualify for WTW, all contacts must have taken place after May 1, 1966.

The following stations have qualified for WTW since the last listing:

WTW-200, 14 MHz Phone:

Certificate #11, K8YBU
12, PY3BXW
13, W6MEM

WTW-100, 14 MHz Phone:
54, K5TGJ
55, K4VKW
56, SV0WL
WTW-100 21 MHz Phone:
13, W6MEM
14, K4VKW
15, WA1EUV
WTW-100, 21 MHz CW:
5, W0RRS
WTW-100, 14 MHz CW:
15, K4CEB

21 MHz Phone still has only W4OPM with #1, and 28 MHz both Phone and CW still await someone to pick up #1.

As soon as enough scores are received, I will start a running list of the number of countries various fellows have worked.

. . . W4BPD

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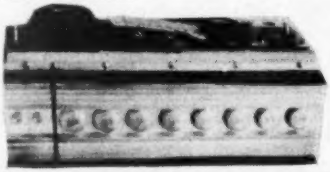

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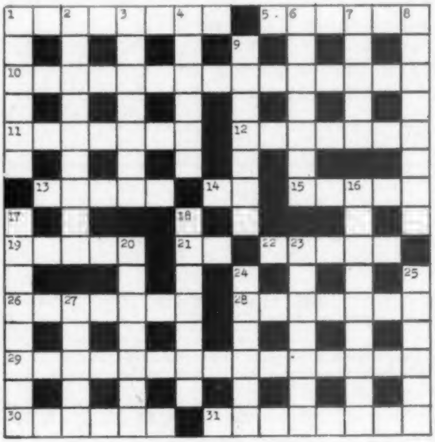

Across

1. An amplifying station used to boost the volume on long telephone lines.
5. Noise heard in a receiver due to atmospheric disturbances.
10. The lack of dilution of a hue by white.
11. Flyback.
12. An electrode used to initiate conduction at the desired points in each cycle.
13. Undesired sound.
14. Aluminum. (Abbr.)
15. To make merry.
19. A series of names, numbers and words.
21. A world-governing body. (Abbr.)
22. The centimeter-gram-second electromagnetic unit of a magnetic induction.
26. Also called piggy-back control.
28. Trade name for a phenolic compound having good insulating qualities.
29. Use of radio signals for course-plotting.
30. To push with sudden force.
31. An electrode whose primary function is to reverse the direction of an electron stream.

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PRV	16A	25A	PRV	16A	25A
50	.50	.75	400	1.60	1.90
100	.95	1.20	600	1.95	2.75
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254, 255, 256, 257, 301 40c@ .....3 for $1
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** 18	.20	.30	.75	1.00
45	.80	1.20	1.40	1.90
160	1.85	2.90	3.50	4.60
240	3.75	4.75	7.75	10.45
D. C. Amps	400Piv 280Rms	600Piv 420Rms	700Piv 490 Rms	900Piv 630Rms
12	1.20	1.50	1.75	2.50
** 18	1.50	Query	Query	Query
45	2.25	2.70	3.15	4.00
160	5.75	7.50	Query	Query
240	14.40	19.80	23.40	Query

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6.3 Vct 15.5A & 6.3 Vct @ 2A $4
7.5 Vct@ 12A $3@ .... 2/$5

Down

1. To preserve for later reproduction.
2. A high-vacuum thermionic tube used to control the magnitude of current flow. (Pl.)
3. Also called antennas.
4. An ionized layer in the atmosphere, about 55 to 85 miles above the earth's surface.
6. Representation of an operating system by computers and its associated equipment and personnel.
7. The rotation of a cross-section of a waveguide about the longitudinal axis.
8. The parts of a digital computer which carry out instructions in proper sequence.
9. Capable of being heard.
16. The transmitted portion of the suppressed sideband.
17. A dielectric that retains a charge after the charging field is removed.
18. A metallic alloy having special magnetic properties.
20. Fixed set of plates in a variable capacitor.
23. Slang expression for radio broadcasting.
24. A position of authority or trust.
25. A refinement added to an impedance bridge to avoid the effects of capacitance to ground.
27. A device, also known as acoustic radar.

Solution Pg. 106

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Solution To Puzzle on Pg. 118

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E	■	L	■	E	■	L	■	9 A	■	R	■	M	■	O
10 C	O	L	O	R	S	A	T	U	R	A	T	I	O	N
O	■	O	■	I	■	Y	■	D	■	I	■	S	■	T
11 R	E	T	R	A	C	E	■	12 I	G	N	I	T	O	R
D	■	R	■	L	■	R	■	B	■	E	■	■	■	O
■	13 N	O	I	S	E	■	14 A	L	■	15 R	E	16 V	E	L
17 E	■	N	■	■	■	18 M	■	E	■	■	■	E	■	S
19 L	I	S	T	20 S	■	21 U	N	■	22 G	23 A	U	S	S	■
E	■	■	■	T	■	M	■	24 O	■	I	■	T	■	25 W
26 C	A	27 S	C	A	D	E	■	28 F	O	R	M	I	C	A
T	■	O	■	T	■	T	■	F	■	W	■	G	■	G
29 R	A	D	I	O	N	A	V	I	G	A	T	I	O	N
E	■	A	■	R	■	L	■	C	■	V	■	A	■	E
30 T	H	R	U	S	T	■	31 R	E	P	E	L	L	E	R

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Propagation Chart

September 1968

ISSUED JUNE 1

J. H. Nelson

EASTERN UNITED STATES TO

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14A	14	14	7	7	7	7	14B	14	14	14	14
ARGENTINA	21	14A	14	14	7A	14	21A	21A	21A	21A	21A	21
AUSTRALIA	21	14	14	7A	7A	7	7B	14	14	14	21	21A
CANAL ZONE	21	14	14	14	7A	7	14A	21	21	21A	21A	21A
ENGLAND	7A	7	7	7	7	14	21A	21	21	21	14A	14
HAWAII	21	14	14	7A	7	7	7A	7B	14A	21	21	14A
INDIA	14B	7B	7B	7B	7B	14	14	14A	14A	14A	14	14B
JAPAN	14	14	7B	7B	7B	7B	7	14B	14B	7B	14	14A
MEXICO	21	14	14	7A	7A	7	14	21	21	21	21A	21A
PHILIPPINES	14	14	7B	7B	7B	7B	14B	14	14	14	14	14
PUERTO RICO	14	7A	7A	7	7	7	14	21	21	21	21	21
SOUTH AFRICA	14	14	7B	14	14	14A	21A	21A	21A	21A	21A	21
U. S. S. R.	7	7	7	7	7	14	14A	14A	14A	14	14	7B
WEST COAST	21	14A	14	7A	7	7	7A	14A	21	21	21A	21A

CENTRAL UNITED STATES TO

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14A	14	14	7	7	7	7	7	14	14	14	14A
ARGENTINA	21	14A	14	14	14	7	21	21	21A	21A	21A	21
AUSTRALIA	21A	21	14	14	14	7A	7B	14	14	14	21	21A
CANAL ZONE	21A	14A	14	14	14	7A	14	21A	21A	21A	21A	21A
ENGLAND	7A	7	7	7	7	7	14	21A	14A	21	14A	14
HAWAII	21A	21	14	14	7A	7	7	7B	14A	21	21A	14A
INDIA	14	14	14	7B	7B	7B	7B	14	14	14A	14	14B
JAPAN	14A	14	14	7B	7B	7B	7	7	14B	7B	14	14A
MEXICO	14A	14	7	7	7	7	7	14	14A	14A	21	21
PHILIPPINES	14A	14	14	7B	7B	7B	7B	7A	14	14	14	14
PUERTO RICO	21	14	14	7A	7A	7	14	21	21	21	21	21A
SOUTH AFRICA	14	14	7B	7B	7B	7B	14A	21	21A	21A	21	21
U. S. S. R.	7B	7	7	7	7B	7B	14	14	14A	14	14	7B

WESTERN UNITED STATES TO

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7	7	7	7	7	7	14	14	14
ARGENTINA	21	21	14	14	14	14	14	21	21A	21A	21A	21
AUSTRALIA	21A	21A	21	14	14	14	14	14	14	14	21	21A
CANAL ZONE	21A	21	14	14	14	7A	14	21	21A	21A	21A	21A
ENGLAND	7A	7	7	7	7	7	7B	14	14	14A	14A	14
HAWAII	21A	21A	21	14A	14	14	14	7	14A	21	21A	21A
INDIA	14	14A	14	7B	7B	7B	7B	7B	14B	14B	14	14B
JAPAN	21	21	14	14	7	7	7	7	14	14	14	14A
MEXICO	21	14A	14	7	7	7	7	14	21	21	21A	21A
PHILIPPINES	21	21	14	14	7	7	7	7	14	14	14	14A
PUERTO RICO	21A	14	14	14	7A	7	14	21	21A	21A	21A	21A
SOUTH AFRICA	14	14	7B	7B	7B	7B	14	14A	21	21	21	21
U. S. S. R.	7B	7B	7	7	7B	7B	7B	14	14	14	14	7B
EAST COAST	21	14A	14	7A	7	7	7A	14A	21	21	21A	21A

A. **Next higher frequency may be useful at this hour.**

B. **Very difficult circuit at this hour.**

Good: 1, 2, 8-13, 16, 17, 19-27

Fair: 3, 4, 6, 7, 14, 18, 28-31

Poor: 5, 14

Note: VHF forecasts have been discontinue due to lack of reliable information.

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ALUMINUM TOWERS

Send postcard for Literature

Dear 73,

After reading some tower construction articles in the July issue of 73, I had a horrible thought; does the average ham realize what the common termite might do to a wooden tower, if given the chance?

Anyone constructing a wooden tower should take all precautions to prevent damage by termites or other pests or decay. Consult your local lumber or hardware dealer for the necessary materials to treat the wood and nearby ground to prevent any such damage.

George S. Stevens WB2ZFA
Mays Landing, N.J.

Dear 73,

I want to take this opportunity to comment on the incentive license study sections in your magazine. I think they are the best. Really, I'm learning more by your type of presentation than I ever could out of the Handbook. I believe that basically the Handbook is designed fror a person who has a basic knowledge of electricity and a little experience of the same. Coming in cold with absolutely no knowledge, the Handbook is very confusing to me. Most of the other hams in the club here think the same. In other words, fine business.

G. Gerald Burger WA0KUA
Secy. Huron Amateur Radio Club

Dear Kayla,

Decidedly like what you are doing. The humor is splendid and your Advance Class course is excellent. Keep laughing and the temptation to wring your hands is not so great. 88 to you too.

Jim Kaufman WA0RD
Boulder, Colorado 80302

Dear Kayla,

The big "40 meter push" which you presented in *73* depicts the beginnings of an excellent campaign. I'm all for, and would like to see *73 Magazine* present and lead a year long marathon designed to eliminate the interference caused by commercial stations on 40 meters. If 73 would follow through with such an "elimination marathon", I promise to urge most of the hams with whom I come in contact to support the campaign.

Possibly *73* can print up some pre-written complaint letters to be signed and mailed by US hams to Radio Moscow, VOA, BBC, etc. I bet we can lick the interference problem in one year with cooperation. How about it *73?*

Marty Hartstein WB6NWW
Long Beach, Calif.

OK, fellows, what say? I'll print up some form letters to be used as petitions. Let's give it a try. It can only cost postage and the work in getting signatures. Any other ideas from readers as to how to better make use of 40 will be appreciated and put to use.

Dear Wayne, Kayla, and Lin,

After a one year trial subscription I decided that *73* was great. I must say your editorials are right on the beam, so to speak. They are my thoughts entirely on almost every subject.

Keep up the good work and put in more humorous articles like Dilemma in Surplus (June '68). Keep putting in lots of ads, I read them word for word. And . . . best of all, put in more pictures with the articles, especially ones about decibels! HI HI.

Brent Christensen WA0STS

Dear 73,

Thought that I would let you know that as lousy as the mail service is over here, I finally received my February issue of your most welcome bit of ham news from the States. My subscription was mailed to you in November at the same time that I mailed subs to the other two. I am getting 73 quite regularly even though late. I must say that I am a bit disappointed with the other two magazines as I have yet to receive my first copy. As you well know, there is no operation here and our only contact with the ham world in the states is through your magazines for which we are very appreciative. There are five hams in our group and by the time the magazine gets around, it is well dog-eared and equally as well read and appreciated. Keep up the good work. Just thought I would toss the roses where they are justly due. We do make good use of it and it does get passed around and then filed in the operating room.

Herb Wright WB6IHE
Saigon, So. Vietnam

Dear 73,

With great interest I read W2NSD's editorial on UFO's. I have been interested for several years in this subject. My views parallel those of the editorial and I hope in the near future I can assist in this proposed program. I do not know if there are any amateurs on this side of the pond that are interested but will do my best to find out. I think it would be of great value to have an arm of the network in Europe. I will keep my ears on 14250 and in the meantime try to scare up some interested parties on this end.

Richard J. Malby
APO New York 09176

Dear 73,

All US hams and relations visiting Spain are all times welcomed at the home of very old OM, V. S. Alexandersen, well known in the Amateur World between 1927-1936 as ET2X, ET3CS and ES3CX. I'm not active anymore, but I'm still a ham. Address Camino Son Toells 37, St. Augustin, Palma De Mallorca, Baleares, Spain.

V. S. Alexandersen

Dear 73,

Please pass along the word that I still have a bulk (300+) of National Zip Code Directory flyers to pass out free to anyone sending a request.

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T-94-2	.94	.56	.31	.75
T-80-2	.80	.50	.25	.60
T-68-2	.68	.37	.19	.50
T-50-2	.50	.30	.19	.45
T-37-2	.37	.21	.12	.40
T-25-2	.25	.12	.09	.30
T-12-2	.125	.06	.05	.25

Yellow "SF" Cores-10 MHz to 90 MHz- $\mu = 8$

#	OD	ID	H	EACH
T-94-6	.94	.56	.31	.95
T-80-6	.80	.50	.25	.80
T-68-6	.68	.37	.19	.65
T-50-6	.50	.30	.19	.50
T-25-6	.25	.12	.09	.35
T-12-6	.125	.06	.05	.25

Black "W" Cores-30 MHz to 200 MHz- = 7

#	OD	ID	H	EACH
T-50-10	.50	.30	.19	.60
T-37-10	.37	.21	.12	.45
T-25-10	.25	.12	.09	.40
T-12-10	.125	.06	.05	.25

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- 5 transistor circuit boards containing up to 6 transistors, plus diodes, resistors, capacitors, etc. Cat. # TB10, 99c.
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- RCA-110° flyback transformer, latest type, includes schematic diagram, applicable to any TV. Cat. # BR-1, $2.99.
- Color yokes. 70° for all round color CRT's. Cat. # XRC70, $12.95. 90° for all rectangular 19 to 25" color CRT's. Cat. # XRC90, $12.95.
- Transistorized U.H.F. tuners used in 1965 to 1967 TV sets made by Admiral, RCA, Motorola, etc. Removable gearing may vary from one make to another. Need only 12 volts d.c. to function. No filament voltage needed. Easy replacement units. Cat. # U.H.F.567, $4.95.
- U.H.F. Tuner—original units as used in TV sets such as RCA, Admiral, etc. covering channels 14 through 82, as part of #94D173-2. Complete with tube. Drive gearing is removable. Can be used in most sets. Cat. # U.H.F. 3, $4.95.
- F.M. tuner—Hi/Fi amplifier tuning unit. Tunes from 88 to 108 mc. Contains two 10.7 Mc. I.F. transformers, one 10.7 sound discriminator, R.F. oscillator and mixer stages and 12DT8 tube. I.F.'s are standard "K" type. Circuit diagram for building F.M. radio included. Also plan for building F.M. tuner. Sam's photofact #620 shows 2 applications, 1 for radio, 1 for Hi-Fidelity tuner and amplifier. Cat. #FM-20, $4.95.

Send for our free catalog listing thousands of similar best buys in tubes, parts, kits, transistors, rectifiers, etc. Orders under $5.00, add 50c handling charge. Include 4% of dollar value of order for postage. Canadian postage $1.00 extra.

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PP468 Power Supply for R316A Receivers 400cy.	LN	4.75
C610 Control Box w/4 Tubes for R316A Recvrs.	EX	4.50
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OHMITE Z-50 Radio Frequency Choke	EX	6/1.00
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BNC (UG290/U Coaxial Panel Sockets	EX	8/1.00
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- ★ **We cannot check into each advertiser, so Caveat Emptor . . .**

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WRL's USED GEAR has trial—terms—guarantee! SR46—$94.50; SR500—$199.95; HW12—$89.95; HW22—$89.95; Galaxy V—$289.95; Galaxy 300—$159.95; TX62—$99.95; 75A3—$229.00; 51J3—$395.00; NC-300—$149.95; RME6900—$149.95. Hundreds more—low prices—free Blue-Book list. Write WRL, Box 919, Council Bluffs, Iowa 51501.

VERY GOOD LATE MODEL NCX 3. Several modifications, outboard 10 kc receiver tune, ALC, and speaker. $150. AC power supply, $35. W7QBT, 890 W. 21 Street, Eugene, Oregon 97405.

WANTED, ANY CONDITION; VOM, VTOM, Weatstone Bridge. Resistance Decade Box, meter monuments. Gil Barber, 4155 E. Carey, Las Vegas, Nevada 89110.

NCX-5 MARK II and NCXA in excellent condition. $450 cash. Write K5TSR, 102 W. Rampart Dr., Apt. Q203, San Antonio, Texas 78216.

HALLICRAFTERS HT 32, like new, $250. Globe King 500A 160 through 10. CW. AM. with your exciter will run 700 watts SSB. ALC, extra final, VFO. $195, like new. 3-5 KVA generator, $200. Ship. John Smith, 1924 Dolphin Blvd., St. Petersburg, Florida 33707.

FOR SALE: HEATH SB-301 rec. with CW filter factory aligned, $260.00. Knight P2 SWR bridge, $10.00. Heath Kit H D-10 electronic keyer, $35.00. Instrograph code practice keyer with full set of tapes, $25.00. Ameco code practice oscillator and CW monitor, $5.00. Value of all equipment new, $390.00. Will sell individually or as package for $325.00. D. Willson, 7803 Dawn Rd., Cincinnati, Ohio 45237.

MODEL #28 KSR, $295.00. Write for list of 10 years' surplus, RTTY, FAX, etc. G. White, 5716 N. King's Highway, Alexandria, Virginia 22303.

WANTED: Issues of 73. Oct. '60 to Dec. '62, Jan. '66 to Dec. '67. Kirt Fanning, 6021 Edgewood, LaFrange, Ill. 60525.

FOR SALE: Motorola 80-D, 12v, complete and a Link 50ufs, 110v base complete, both on 52.525HZ. $120 for the pair. WA9GVE, 7424 Illinois Rd., Fort Wayne, Indiana.

FOR SALE: Clegg Apollo Six Linear Amplifier. Brand new! Below cost! Contact Jack Batts, Five Old Tavern Road, Wayland, Mass. 01778. Phone 653-6891.

NORELCO VIDEO TAPE RECORDER in perfect condition, tape and all additional parts included; CCTV camera—$115.00, Vidicon—$10.00, Vidicon Yoke—$10.00, Elgeet 4" Telephoto lens—f2.7; Reverb—$15.00; Simpson 260 VOM—$35.00; Heath RF Signal Generator IG-102, $15.00; EICO R-C Bridge & RLC Comparator—$18.00; Tachometer—$10.00. Wanted: 6M SSB Transceiver. WB2GKF, 506 Mount Prospect Avenue, Clifton, N.J. 07012.

FOR SALE: Complete Hallicrafters station in excellent condition. HT-37, and SX-100 with R-66B speaker. $300. James Winter, RR 2, Huron, S.D. 57350.

THE HAM-DINGER: Warren (Ohio) A.R.A. 11th Annual Hamfest, Sunday, August 25, Newton Falls, rain or shine. Follow arrows from Rt. 534 or Turnpike Exit 14. Talk-in stations, 10-6-2-. Prizes, swapshop, homebrew-code contests, XYL-YL program, ragchews galore. Food sold or bring picnic. For Hamfest bulletin write W.A.R.A., Box 809, Warren, Ohio 44481.

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HALLICRAFTERS HT32B; $275; NC-300, $125; matching pr 813's GG linear with pwr supply, $50; TR-4 with ac pwr supply and speaker, $500. Beautiful. K6SUQ, 5 Rydal Court, Orinda, Calif. 94563.

WANTED: Heath-VX-1. Also G-76 AC power supply, must be in fine condition. Cash. G. Gysan, 53 Lothrop St., Beverly, Mass. 01915. Phone 922-3850.

FOR SALE: VHF EQUIPMENT: 6 meter SSB, HX-30 and HA-20 linear, factory wired, mint condition with manuals, $245.00. Gonset communicator II-B, 6 meters, 12/117v in mint condition with manual, $115. Gonset #3350, G-76 DC power supply (all transistor), $50.00. W1VYB-J. Gysan, 53 Lothrop Street, Beverly, Mass. 01915. Phone: 922-3850.

TOROIDS, uncased 44 or 88mH, also individually epoxy encased 88mH for standards, any 5, $1.50. 255A relay $2.10, 18B socket 70¢ all PP USA. E. W. Evans, K4OEN, 220 Mimosa Ln., Paducah, Ky. 42001.

"SAROC" FOURTH ANNUAL fun convention scheduled January 8-12, 1969, in Hotel Sahara's new space convention center, Las Vegas, Nevada. Advance registration closes January 1, 1969. Ladies program in Don the Beachcomber. Technical seminars, FM, MARS, RTTY, QCWA, WCARS-7255. Registration $12.00 per person entitles "SAROC" participants to special room rate $10.00 plus room tax per night single or double occupancy, admittance to cocktail parties, technical seminars, exhibit area, Hotel Sahara's late show, Sunday breakfast equal to any banquet dinner, ask any "SAROC" veteran. Brochure planned November mailing for details QSP QSL card with ZIP Southern Nevada ARC, Box 73, Boulder City, Nevada 89005.

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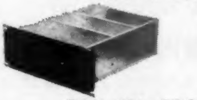

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3000 V @ 3μF brand new GE Pyronal oil capacitors $3 each. Can mail. 3-lbs each shipping wt., FOB. P. Wandelt, RD # 1, Unadilla, New York 13849.

WANTED: Military, commercial, surplus Airborne, ground, transmitters, receiver, testsets accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

CLEGG VENUS 6 M SSB serial 100 33 w/ac ps and APOLLO LINEAR 1200 265. Both units recently factory checked. Included SS Booster 708 308. Everything $450.00. Eastern Penna. Write Box 968, c/o 73 Magazine.

SELL. Excellent CE100V, $495. Kent Markel, Box 144A RR 1, Lexington Park, Maryland 20653. 301-863-5967.

FOR SALE: SX101—$100; Knight R100A—$70; Ranger II—$150; DX60—$40; HW32—$75. Don Ahonen, Rt. 1, Bx 291A, Lisle Road, Owego, New York 13827.

WANTED: HA-10 LF/MF tuner, new or used. F. Rafalowski, 525 Home Ave., Trenton, New Jersey 08611.

SELL/TRADE: Collins mechanical filters, F455N-20 (2kc), F455N-30 (3kc), F455N-40 (4kc), on partially canabalized Collins sub-chassis 5407577006. Will remove filters or send sub-assembly. Trade for or buy 500kc filters for 51J4 receiver: F500B-31, F500B-14, F500B-08, or what have you that fits? W. A. Kernaghan, 1752 Kilohi St., Honolulu, Hawaii 96819.

FOR SALE: Thunderbolt. Complete with spare tubes. Will ship. $225. K6HLO, 511 Oak St., Roseville, California 95678.

THE CENTRAL NEW YORK CHAPTER OF QCWA will hold its annual banquet and meeting on September 28, 1968, at Hanson's Hotel, Oquaga Lake, Deposit, New York. Cocktail QSOs from 5 to 7 p.m. Buffet dinner at 7 p.m. and business meeting and election of officers at 8:30 p.m. All QCWA members are invited to attend and enjoy this program. Use exit 83 from the East, exist 82 from the West, on route 17. Tickets $5. For further information contact Clark Galbreath W2AXX, 111 Keeler St., Endicott, N.Y. 13760.

FOUR CORNERS FIELD DAY! September 21, 22. Club station K5WXI will operate 15, 20, 40 and 80 meters SSB and CW day and night. "5 Ø 7" award for working this station.

THE FOUNDATION FOR AMATEUR RADIO will hold its annual Hamfest on Sunday, September 22 from 1000 until 1700 hours at the Gaithersburg Fairgrounds in Gaithersburg, Md.

THE IOSCO RADIO CLUB presents its 4th annual Northeastern Michigan Hamfest on October 4, 5, 6 at East Tawas, Mich. 60 miles north of Bay City on US 23. Programs will begin Friday, October 4, at 6 p.m. ending Sunday afternoon at 3 p.m. For additional information contact Jerry Mertz W8DET or Glenn A. Pohl K8IYZ.

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☐	3-2N3683, NPN, 1000MC, 5MA, 200MW	$1.00
☐	3-14 WATT, B-5000, npn, 3A	$1.00
☐	4-2N4313, PNP, 600MC, 200MW	$1.00
☐	4-2N3565, 500HFE, npn, 200MC	$1.00

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Tested, with data sheets

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☐	956 DUAL INPUT BUFFER	$1.00

100's of other IC's including: Flip-Flops, Registers, Adders, etc. Write for listing.

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☐	904-904*	Half Adder	$1.69
☐	914-914*	Dual 2 Input Gate	$1.49
☐	923	JK Flip Flop	$1.69
☐	923-923*	JK Flip Flop	$1.98
☐	927	Quad Inverter	$1.69

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600	☐ .20	☐ .55	☐ .75	☐ 1.80
800	☐ .30	☐ .75	☐ .90	☐ 2.30
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